IEEE Convention 67

IEEE International
Convention
and Exhibition

Technical Program

New York Hilton Hotel

The 1967 IEEE International Convention and Exhibition opens Monday morning, March 20. There will be 72 technical sessions plus one Highlight Session. New this year is a *Convention Digest* to be sold during the convention. It will contain a 1000-word synopsis of each paper or, in the case of informal panel discussions, a 1000-word synopsis of the entire session. The *Convention Record*, containing complete versions of all available papers, will not be obtainable at the convention but may be ordered for later delivery.

March 20-23
1967

1967 IEEE INTERNATIONAL CONVENTION-SESSION CHART

	Gramercy Suite	Murray Hill Suite A	Murray Hill Suite B	Nassau Suite	Regent Room	Rhinelander Gallery North	Rhinelander Gallery South	Sutton Ballroom North	Sutton Ballroom South
MONDAY, MARCH 20 9:30 A.M. — 12:00 Noon	SESSION 1 Computer Aided Learning	SESSION 2 Numerical Techniques in Optimization	SESSION 3 Microwave Communications	SESSION 4 The City of Tomorrow	SESSION 5 Electromagnetic Compatibility in Systems Design	SESSION 6 Improving Oral Communication Through the Application of Modern Equipment	SESSION 7 The Growing Inventory of Microwave Components	SESSION 8 Avionics Systems for Rotary Wing Aircraft	SESSION 9 Reliability Design & Testing — Case Studies
MONDAY, MARCH 20 2:00 P.M. — 4:30 P.M.	SESSION 10 The Impact of Electronic Techniques on Education	SESSION 11 Plant Optimization and Statistical Filtering	SESSION 12 System Interfaces for Global Communications	SESSION 13 Principles of Advanced Information Processing (In Cybernetics)	SESSION 14 Systems with On-line Computer Control	SESSION 15 Solid-State Devices Frontiers	SESSION 16 Microwave Miniaturization — A Progress Report	SESSION 17 Integrated Avionics — Today & Tomorrow	SESSION 18 Engineering in Surgery
TUESDAY, MARCH 21 9:00 A.M. — 11:30 A.M.	SESSION 19 Control Techniques in the Steel Industry	SESSION 20 Applications of Digital Computers in Control	SESSION 21 Wire Communication I — New Developments in Exchange Transmission	SESSION 22 The Computer for Basic Research in the Humanities & Behavioral Sciences	SESSION 23 State- and n-Variable Realizations and Filter Design	SESSION 24 The State of the Tube Art	SESSION 25 A Survey of Computer Operating Systems	SESSION 26 On Board Check-out for Aerospace Systems	SESSION 27 The Design of Man → Man's Design.
TUESDAY, MARCH 21 2:00 P.M. — 4:30 P.M.	SESSION 28 Electromagnetic Phenomena in Plasmas	SESSION 29 System Simulation	SESSION 30 Wire Communication II — New Developments in Wire Communications	SESSION 31 Managerial Action & Organizational Effectiveness	SESSION 32 Automation of Marine Power Systems	SESSION 33 Quantum Electronic Devices & Energy Conversion Devices	SESSION 34 How to Apply System Analysis Properly to Biological Systems	SESSION 35 Controlling Air Traffic in "Super Jet" Age	SESSION 36 Space Communications
TUESDAY, MARCH 21 8:00 P.M. — 10:30 P.M.	SPECIAL HIGHLIGHT EVENING SYMPOSIUM GRAND BALLROOM				EXPLOITATION OF THE WORLD'S OCEANS — ELECTRONICS ROLE				
WEDNESDAY, MARCH 22 9:00 A.M. — 11:30 A.M.	SESSION 37 Advanced Electrical & Electronic Materials	SESSION 38 Continuing Engineering Education	SESSION 39 Advances in Data and Telegraph Systems and Facsimile	SESSION 40 Illumination Today and Tomorrow	SESSION 41 The Impact of EDP on Engineers and Management	SESSION 42 Computer Design of Networks I	SESSION 43 New Horizons in Science and Engineering I	SESSION 44 Exploitation of the World's Oceans II	SESSION 45 Signal Design and Detection
WEDNESDAY, MARCH 22 2:00 P.M. — 4:30 P.M.	SESSION 46 Integrated Circuits — Their Current Technology & Economic Status	SESSION 47 Social Aspects of Automation	SESSION 48 Methods in High Speed Data Transmission	SESSION 49 Ultrasonics in Modern Signal Processing	SESSION 50 Drive Control Applications	SESSION 51 Computer Design of Networks II	SESSION 52 New Horizons in Science and Engineering II	SESSION 53 Professional Relations and the Institute	SESSION 54 Communication Channels — Theory Versus Practice
THURSDAY, MARCH 23 9:00 A.M. — 11:30 A.M.	SESSION 55 The Deep-Sea Challenge to Electronic Hardware Designers	SESSION 56 Applications & Components	SESSION 57 New Service for the Telephone User	SESSION 58 Human Factors in High Speed Transportation	SESSION 59 What's New In Measurements	SESSION 60 Integrated Digital Circuits	SESSION 61 Infrared Techniques for Nondestructive Testing	SESSION 62 The Electronics Industry — An Outlook for Engineers and Management	SESSION 63 Speech — Man's Natural Communication
THURSDAY, MARCH 23 2:00 P.M. — 4:30 P.M.	SESSION 64 Electrical Corona	SESSION 65 Instrumentation for Underwater Research	SESSION 66 Reliability Field Experience in Electronic Switching Systems	SESSION 67 Man in Complex Systems	SESSION 68 Expanded Broadcast TV Coverage Through the Medium of CATV	SESSION 69 Integrated Analog Circuits	SESSION 70 Antenna & Scattering Techniques for Determining Surface Characteristics	SESSION 71 Information Retrieval	SESSION 72 Speech Processing

TECHNICAL PROGRAM

All the technical sessions will be held at the New York Hilton (Avenue of the Americas at 53 St.) during the following hours:

Monday	9:30 A.M. — 12:00 Noon 2:00 P.M. — 4:30 P.M.
Tuesday through Thursday	9:00 A.M. — 11:30 A.M. 2:00 P.M. — 4:30 P.M.

A schedule of 72 technical sessions plus one Special Highlight Symposium appears on the facing page. The Highlight Symposium—Exploitation of the World's Oceans—will be held on Tuesday evening from 8:00 p.m. to 10:30 p.m. Abstracts of the papers to be presented begin on page 37.

THE IEEE EXHIBITION

The IEEE Exhibition at the New York Coliseum (Columbus Circle at 59 St.) will be open from 10:00 a.m. to 8:00 p.m. on Monday through Thursday. The multimillion dollar exhibition will occupy all four floors of the Coliseum. On the first floor there will be exhibitors of production equipment and hardware as well as publishers and consultants. The second floor will be devoted to exhibitors of instruments and systems. The third and fourth floors will contain component exhibits.

COCKTAIL PARTY

The traditional cocktail party will be held once again this year. It is scheduled for Monday, March 20, from 5:30 to 7:30 p.m. in the East Ballroom of the New York Hilton.

ANNUAL BANQUET

Howard W. Johnson, President of MIT, will be the principal speaker at the annual banquet, which will be held in the Grand Ballroom of the New York Hilton on Wednesday, March 22. The doors will open at 6:30 p.m. and the banquet proceedings will begin at 7:15 p.m.

The banquet will feature the presentation of the IEEE Medal of Honor and the following IEEE Major Awards—Edison Medal, Founders Award, Lamme Medal, and Education Medal. In addition, the recently elected Fellows will be recognized.

LADIES' PROGRAM

An entertaining program of tours and shows has been arranged for the wives of members who are also invited to the cocktail party and the annual banquet. Ladies' Headquarters will be located in the Beekman Room on the second floor of the New York Hilton.

INTERNATIONAL RECEPTION ROOM

Members of the International Reception Committee will be on hand in the International Reception Room at the Rhinelander Gallery North on the second floor promenade of the New York Hilton to greet visitors in their native tongues and to provide them with any needed assistance.

REGISTRATION

All persons attending the 1967 IEEE International Convention and Exhibition may register at either the New York Hilton or the New York Coliseum. Registration hours at the Hilton will be from 2:00 p.m. to 7:00 p.m. on Sunday and from 9:00 a.m. to 5:00 p.m. on Monday through Thursday.

Registration fees will be $2.00 for IEEE members including student members; $5.00 for nonmembers; and $1.00 for women. High school students will be admitted upon payment of $2.00 and if accompanied by an adult. There will be a limit of one student for any one adult on Monday, Tuesday, and Wednesday and a limit of three students for any one adult on Thursday. Members of the military may register for $2.00 (including civilian employees of Government establishments). There will be no fee for registration of IEEE members from outside the U.S.A.

CONVENTION DIGEST

This year, for the first time, a *Convention Digest* will be sold during the convention. It will contain a 1000-word synopsis of each paper or, in the case of informal panel discussions, a 1000-word synopsis of the entire session.

CONVENTION RECORD

The *Convention Record*, containing complete versions of all available convention papers, will not be obtainable during the convention. However, it may be ordered and paid for during the convention for shipment at a later date. An order form for the 14-part *Convention Record* appears on page 36.

FILM THEATER

A film theater sponsored by the IEEE Group on Education will be held each day during the convention from 10:00 a.m. to 8:00 p.m. in the France Room at the New York Coliseum. The theater will be open to all registrants at the convention. It will have three groups of showings each day of current films of technical interest.

As an experiment in improved communications, an edited and compressed speech taped version of the Tuesday night Highlight Session will be presented on Thursday morning utilizing audio and slides. The method to be employed is that described in the paper, "Speech Compression in Theory and Practice: A Lecture-Demonstration" on Monday morning as part of Session 6 sponsored by the Group on Engineering Writing and Speech. In the method, audio tape is speeded up and the pitch of the voice is reduced to normal by a rotating tape head.

POLYTECHNIC INSTITUTE OF BROOKLYN SYMPOSIUM ON MODERN OPTICS

The Polytechnic Institute of Brooklyn has rescheduled its usual spring symposium so that it well be held during the week of the IEEE Convention. The 1967 PIB Symposium on Modern Optics will be held at the Waldorf Astoria, March 22–24, 1967. The PIB Symposium registration fee has been waived for IEEE Convention registrants. Registration opens at 8:30 a.m. on Wednesday, March 22, and the first session begins at 9:00 a.m.

There are twelve sessions scheduled. The opening session on Wednesday morning features two papers: one on optical coherence; the other on nonlinear phenomena. The Wednesday luncheon will have an address on Project Hindsight. The remaining sessions will cover the following topics: laser interferometry, holography, coherence, acoustic interactions, nonlinear optics, lasers, electrodynamics and diffraction, information transmission and processing, and atmospherics and X-ray astronomy.

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1967 IEEE INTERNATIONAL CONVENTION RECORD

The *IEEE International Convention Record*, containing all available 1967 convention papers, will not be available until after the convention. However, it may be ordered and paid for during the convention for delivery at a later date. Any of the booths at the New York Hilton and New York Coliseum where the *Convention Digest* is being sold will also handle orders for the *Convention Record*. Prices for the various parts of the *Convention Record* are given below.

For the convenience of those who wish to order by mail for delivery after the Convention, an order form is at the bottom of this page. Simply clip it out, fill in the necessary information and mail it with your remittance to:

The Institute of Electrical and Electronics Engineers, Inc.,
345 East 47 Street, New York, N.Y. 10017.

When ordering, please be certain to refer to the proper column for subjects and prices.

Nonmembers and libraries may place orders at the nonmember and library rates, respectively. Individuals who apply for IEEE membership at the time they place their orders are entitled to the IEEE member rate.

Part	Sessions	Subjects	Prices for IEEE Members (M), Libraries & Sub. Agencies (L), and Nonmembers (NM)		
			M*	L	NM
* One copy at special member rate; additional copies purchased at Nonmember rate.					
1	21, 30, 39, 48, 57, 66	Wire & Data Communication	$ 2.00	$ 4.50	$ 6.00
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12	31, 41, 43, 52, 53, 62	Engineering Management; Professional Relations	2.00	4.50	6.00
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14	9, 38, 61	Reliability; Industrial Electronics	1.50	3.50	4.50
		Complete set (14 Parts)	$28.00	$63.50	$84.00

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SPECIAL HIGHLIGHT EVENING SYMPOSIUM

Tuesday 8:00–10:30 P.M.
New York Hilton, Grand Ballroom

Exploitation of the World's Oceans

Chairman: The Honorable R. A. Frosch, Assistant Secretary of the Navy (R & D), Washington, D.C.

Keynote Address: National Goals Being Developed by the U.S. National Council on Marine Resources and Engineering Development

The Engineer's Role, T. C. Kavanagh, Chairman, Committee on Ocean Engineering, National Academy of Engineering, Washington, D.C.

The Industry's Role, Richard Fuller, Vice President, Oceanic Instrument Group, Bendix Corp., N. Hollywood, Calif.

R & D's Role, R. W. Morse, President, Case Institute of Technology, Cleveland, O.

Government Agencies' Role, C. M. Herzfeld, Director, Advanced Research Projects Agency, Department of Defense, Washington, D.C.

Panel discussion with audience participation

NOTE: As an experiment in improved communication, the Highlight Symposium will be repeated by compressed audio and slides on Thursday morning at the Film Theater in the France Room at the Coliseum.

SESSION 1

Monday 9:30 A.M.–12:00 Noon
New York Hilton, Gramercy Suite

Sponsored by Education Group

Computer Aided Learning

Chairman: D. W. Healy, Jr., Dept. of Electrical Engineering, Univ. of Rochester, N.Y.

This session has been organized by the IEEE Group on Education to acquaint interested persons with educational activities in which the computer plays a central role, either by virtue of its immediate availability for use in all kinds of problem solving or by its systematic utilization and exploitation as a teaching–learning device. The speakers all represent groups or activities that have had significant experience of this nature and are well qualified to contribute to this program.

1.1 Time-Shared Computers in Design Education, *P. T. Shannon, Myron Tribus, S. A. Gembicki, Thayer School of Engineering, Dartmouth College, Hanover, N.H.*
The fundamental idea in time-sharing is the extremely fast parallel servicing of multiple users. The man–machine interaction possible with a time-shared conversational computing system can reduce the time from problem statement to solution by 10–100 times that possible in most batch environments.

The effect of the time-shared computer at Dartmouth has been to produce an educational environment where the numeric answer to a problem becomes secondary to problem formulation and where computer capability has drastically increased the scope of problems that the students may experience. This is especially true in design education. Operating experience over the last three years and projections for the future are presented.

1.2 Strategies for Design of Computer Aided Learning Exercises, *K. L. Zinn, Center for Research on Learning & Teaching, Univ. of Michigan, Ann Arbor*
Two levels of strategy involved in the design of computer-aided learning exercises are discussed. The first concerns the arrangement of learning material in a pattern and sequence that facilitates learning for each individual student via a computer-based system. The second concerns the procedure by which an effective arrangement is derived from the knowledge and experience of subject experts and the use of material with typical students.

1.3 The Eliza Program—Conversational Tutorial, *E. F. Taylor, Massachusetts Institute of Technology, Cambridge*
The ELIZA Program provides a method for tutoring students and assisting them in calculations and problem solving. Examples are given of Teletyped conversations in natural English (including "natural" algebra) between students on a large general-purpose time-shared computer.

Both ELIZA and the symmetric list processing language (SLIP embedded in MAD on which it is based) were developed by Prof. Joseph Weizenbaum of Massachusetts Institute of Technology. It is currently in use on two IBM 7094 computers; one at M.I.T., project MAC, and one at the M.I.T. Computation Center.

1.4 Teaching by a Computer-Base Instructional System, *D. L. Bitzer, Coordinated Science Lab., Univ. of Illinois, Urbana*
During the past six years the Coordinated Science Laboratory of the University of Illinois has developed and experimented with a computer-controlled teaching system called PLATO. In addition to computer-controlled experiments in mathematics, science, and psychology, the teaching experiments include three university credit courses given wholly or in part on PLATO, including a course in circuit analysis for electrical engineering students.

SESSION 2

Monday 9:30 A.M.–12:00 Noon
New York Hilton, Murray Hill Suite A

Sponsored by Automatic Control Group

Numerical Techniques in Optimization

Chairman: Michael Athans, Massachusetts Institute of Technology, Cambridge

2.1 Application of Numerical Optimization Techniques to Aerospace Problems, *A. E. Bryson, Jr., Div. of Applied Physics, Harvard Univ., Cambridge, Mass.*
Applications discussed include: minimum drag bodies of revolution in hypersonic flow; minimum time orbit transfer; minimum time aircraft climb paths; minimum fuel aircraft climb paths with a sonic-boom constraint;

minimum energy loss re-entry flight paths; and stochastic optimal controller for an intercept missile and an airplane autopilot.

2.2 Computational Algorithms in Optimal Control, *R. E. Kopp, Research Dept., Grumman Aircraft Engineering Corp., Bethpage, N.Y.*

Several numerical approaches for the solution of optimal control problems are discussed and some of the current research being pursued in this area is outlined. A principal difficulty associated with past numerical approaches has been the choice of initial parameters and/or functions associated with the particular algorithm.

2.3 Computational Aspects of Dynamic Programming, *R. E. Larson, Research Engineer, Information and Control Group, Stanford Research Inst., Menlo Park, Calif.*

Dynamic programming has long provided a powerful approach to variational control problems. However, because of the large computational requirements of the classical computational algorithm, its application has been limited to relatively simple problems. Several recently developed algorithms that have greatly reduced computational requirements are described and discussed.

SESSION 3

Monday 9:30 A.M.–12:00 Noon
New York Hilton, Murray Hill Suite B

Sponsored by Radio Communication Committee of Communication Technology Group

Microwave Communications

Chairman: H. G. Portz, Stromberg-Carlson Co., Rochester, N.Y.

This session contains a broad spectrum of papers ranging from an investigation of refractivity revealing fine detail in the microstructure of the atmosphere to a description of a complete communications system extending over 1000 miles in length.

Topics treated include design of 2–8-GHz modularized equipment, design of all solid-state broadband 2-GHz equipment, and theory and design of space diversity systems featuring the use of automatic RF phase shifting for improved performance.

3.1 Applications of a Continuous Measurement Refractometer, *W. Von Hagen, Northern Electric R & D Labs., Ottawa, Ont., Canada*

A new instrument uses an air-dielectric capacitor to sense changes in air refractivity as small as one N-unit. It is combined with a temperature sensor, and raised by balloon to obtain the vertical gradient of refractivity. Measured M-profiles show very fine detail in the microstructure of the atmosphere. Applications are discussed.

3.2 An All-Solid-State Broadband 2-GHz Communication System, *K. Yamazaki, K. Takeda, M. Ogi, T. Sekizawa, J. Dodo, Fujitsu Labs., Fujitsu Ltd., Kawasaki, Japan*

An all-solid-state 2-GHz broadband radio communication system is discussed in which 600 telephone messages or one television program for long-haul application and for short-haul use up to 960 telephone channels can be transmitted.

3.3 Design of Space Diversity Receiving and Transmitting Systems for Line-of-Sight Microwave Link, *Hideo Makino, Kazuo Morita, Electrical Communication Lab., Nippon Telegraph and Telephone Co., Tokyo, Japan*

Severe fading that occurs on line-of-sight microwave propagation paths is a substantial factor impairing quality and reliability of the link in the form of noise bursts and interruptions.

Space diversity receiving and transmitting systems are described that were developed by the Electrical Communication Laboratory of N.T.T. for reducing the deterioration of transmission quality of microwave links due to fading. Design methods, theoretical analysis of the transmission improvement, the explanation of equipment, and several examples of diversity effects on fading are described.

3.4 Colorado River Storage Project Communication System, *A. H. Siniawsky, Stromberg-Carlson Co., Rochester, N.Y.*

A 7-GHz multichannel radio system installed in the Rocky Mountain region of the United States for monitoring and controlling power production is described. Unique features include difficult mountain top construction, extraordinarily long line-of-sight paths, and special thermal design of the equipment buildings.

3.5 Adaptive Control of Modulation Index in Tropo-Scatter Communication, *W. Sichak, R. T. Adams, J. Crawford, Communication Systems, Inc., Paramus, N.J.*

By varying the FM modulation index, a tropo-scatter link can be adjusted either to reduce intermodulation distortion effects or to minimize noise by FM improvement. The design philosophy, novel circuits, and field tests of an experimental unit to improve tropo-scatter signal-to-noise ratio by adaptive FM index control are described.

SESSION 4

Monday 9:30 A.M.–12:00 Noon
New York Hilton, Nassau Suite

Sponsored by System Science and Cybernetics Group and Research Committee

The City of Tomorrow

Chairman: Heinz von Foerster, Electrical Engineering Research Lab., Univ. of Illinois, Urbana

Utopias have lately become drab and stale. The cause for this decline in our ability to make congruent projections of the human condition or just any coherent description of future states of affairs that are either to be achieved or else to be avoided, is today's ever-accelerating transformation of our socio-cultural structure, which expresses itself not only in the escalation of quantities but especially in an evolution of qualities. Science fact has outpaced science fiction.

There are singular points of interest in this transformation process, and one of these is undoubtedly the city. With today's doubling time of 30 years for the entire world population, small and medium-sized cities all over the world double in size in from 5 to 15 years.

What motivates man to cluster in dense settlement, what are the payoffs for reduction in "mean free path," and how does one plan the city of tomorrow to provide the desired commodities?

These problems are discussed from a systems point of view, first, by establishing the facts on urbanization as they are known today to anthropologists and sociologists, and second, by developing the methodology and the concepts that are necessary to cope with one of the most urgent and extraordinarily complex system theoretical problems.

4.1 Peruvian Squatter Settlements as Self-Organizing Systems, *William Mangin, Dept. of Anthropology, University of Syracuse, N.Y.*

Urban planners seldom know the needs and wants of most community's residents and seldom have access to decision-making power. Politicians occasionally know their communities, but often make decisions uninfluenced by community residents or planners.

Popular initiative and community action on the part of community residents are rare in urban areas, but the different consequences of the use of social conflict to attempt to solve some urban problems in Peru and the United States suggest that they may play an increasing role in the city of tomorrow.

4.2 Geometric Configurations: Their Systems and Social Implications, *W. A. Netsch, Skidmore Owings & Merrill, Chicago, Ill.*

Current visual environment assumes existing building types as eternal objects. However, with the influence of contemporary technology on the social and visual boundary a new evaluation of traditional concepts regarding the shaping of our environment's structure is necessary. The assumption of the "eternal object" is challenged and approaches are presented that incorporate technological growth into the sociovisual evolution.

4.3 Urban Structure, *Christopher Alexander, Dept. of Architecture, Univ. of California at Berkeley*

The problem of urban structure is discussed.

4.4 Urban Node in the Information Network, *Paul Baran, Rand Corp., Santa Monica, Calif.; Martin Greenberger, Massachusetts Institute of Technology, Cambridge*

Some of the major contemporary problems of cities are considered and the question is asked as to how the fast developing technologies of computers and communications can help. In the process we take a glimpse of an evolving role that future cities may play as nodes in national and transnational information networks.

SESSION 5

Monday 9:30 A.M.–12:00 Noon
New York Hilton, Regent Room

Sponsored by Electromagnetic Compatibility Group

Electromagnetic Compatibility in Systems Design

Chairman: A. H. Sullivan, Jr., HRB-Singer Inc., Washington, D.C.

Panel Discussion

The session is devoted to a panel discussion of electromagnetic compatibility in system design in four areas of radio: land mobile communications, military communications, aerospace communications, and satellite communications. Each speaker discusses the measures to be taken, and the precautions to be observed, in the design of the system to achieve maximum spectrum utilization. The discussion covers the effects of interaction between system components, the measures to be taken to minimize the interaction between systems, and the effect of the environment on the system. A discussion and questions from the floor follow the initial presentations.

Jona Cohn, *Motorola Inc., Chicago, Ill.*

John Roman, *Naval Ship Systems Command, Electronic Systems Design Section, Department of the Navy, Washington, D.C.*

R. W. Evans, *Chief RFI Unit, RF Systems Branch, Instrumentation Div., Astrionics Lab., Marshall Space Flight Center, NASA, Huntsville, Ala.*

W. D. McKerchar, *McDonnell Aircraft Corp., St. Louis, Mo.*

J. B. Potts, *Transmission Systems Div., Communications Satellite Corp., Washington, D.C.*

SESSION 6

Monday 9:30 A.M.–12:00 Noon
New York Hilton, Rhinelander Gallery North

Sponsored by Engineering Writing and Speech Group

Improving Oral Communication Through the Application of Modern Equipment

Chairman: E. E. Grazda, Hayden Publishing Co., New York, N.Y.

This session begins with an illustrated talk aimed at the working engineer who needs to know what techniques will get the most from visual aids he can produce himself or with little help. A lecture–demonstration on speech compression, using a part of the first talk as an example, follows, although for most effective editing it will have been prerecorded and precompressed, and emphasis is placed on how the compression was done. The final talk covers the use of speech compression in teaching, with particular attention to faster communication and better retention.

6.1 Planning and Producing Better Visual Presentations, *J. T. McGarry, Eastman Kodak Co., Rochester, N.Y.*
The engineer who knows what effective visual presentations can do for him has a great advantage in the oral communication of his ideas. But as visualizor–producer, he must give careful consideration to the needs of his audience and to the best possible use of the available materials.

6.2 Speech Compression in Theory and Practice—A Lecture-Demonstration, *S. F. Temmer, Pres., Infotronic Systems, Inc., New York, N.Y.*
Nearly all of the wealth of research into the comprehension of compressed speech and its applications in education and communication has proved positive and encouraging. This lecture-demonstration deals with the hardware available to accomplish this. The demonstration consists of the compression of a previously recorded IEEE technical paper.

6.3 Implication of Speech Compression for Academic and Industrial Education, *R. D. Gates, Tech Rep. Div., Philco-Ford Corp., Ft. Washington, Pa.*
Modern technology has resulted in an emphasis on oral communication and thus on the efficiency of listening. Research is needed to determine the most effective use of rate changing in speech in both education and business. Education of the blind has been principally emphasized to date but other applications deserve investigation.

SESSION 7

Monday 9:30 A.M.–12:00 Noon
New York Hilton, Rhinelander Gallery South

Sponsored by Microwave Theory and Techniques Group

The Growing Inventory of Microwave Components

Chairman: D. D. King, Director, Electronics Research Lab., Aerospace Corp., Los Angeles, Calif.

Microwave components performing new circuit functions and/or showing radically improved performance of known functions are presented with the user in mind.

The continued growth of the microwave components inventory gives the system designer an ever-increasing stock of "building blocks" to implement his system objectives more effectively. This session is designed to bring together in one place the latest status of microwave building blocks.

7.1 Solid-State Microwave Power Sources, *Fred Sterzer, Radio Corp. of America, Electronic Components and Devices, Microwave Applied Research Lab., David Sarnoff Research Center, Princeton, N.J.*
The state of the art of the following microwave solid-state power sources is reviewed: UHF and microwave transistor amplifiers and oscillators, microwave transistor–oscillator multipliers and transistor–amplifier multipliers, transistor-driven harmonic generator chains, Gunn oscillators, and avalanche diode oscillators.

7.2 Low-Noise Microwave Receivers, *W. G. Matthei, Micro State Electronics Corp., Murray Hill, N.J.*
Microwave receivers are continually undergoing an improvement in their characteristics by an unrelenting upgrading of their solid-state components. A review is presented of the recent solid-state developments in microwave parametric amplifiers (paramps), transistors, tunnel diode amplifiers (TDA), mixers, millimeter receivers, and bulk-effect amplifiers.

Very low noise, uncooled, and liquid-helium-cooled paramps, an avalanche transit-time diode-pumped paramp, and the latest state of the art of millimeter paramps are discussed. The incursion of transistors into the *L*- and *S*-band region, and their sharing of the low-noise preamplifier functions with the TDA is noted. Two new solid-state transit-time amplifiers and mixers, Schottky barrier mixer diodes, and an improved low-noise narrow-band mixer, are presented as competitive components when compared with the transistor or TDA. A brief review is given of some of the new receivers being fabricated using only microwave integrated circuitry (with hybrid and monolithic components).

7.3 Microwave Delay Lines, *R. W. Damon, Sperry Rand Research Center, Sudbury, Mass.*
Solid-state delay lines operating at microwave frequencies can provide many advantages over conventional delay techniques. These devices use sound waves or magnetic spin waves to obtain fixed, variable or dispersive delay behavior. The principles of operation and typical performance characteristics in each of these modes are described.

7.4 Microwave Control Circuits, *D. H. Temme, M.I.T. Lincoln Lab., Lexington, Mass.*
The characteristics and performance of present-day diode and ferrite devices as switches, phasers, attenuators, duplexers, limiters, and modulators are given. Items discussed include insertion loss, isolation, bandwidth, peak and average power-handling capability, control speed, and control power. Some comparisons between diode and ferrite devices are made.

7.5 Microwave Filters and Diplexers, *Leo Young, Stanford Research Institute, Menlo Park, Calif.*
A review of recent developments in microwave filters is presented. Included are fixed tuned and electronically tunable filters, as well as a description of diplexing filters.

SESSION 8

Monday 9:30 A.M.–12:00 Noon
New York Hilton, Sutton Ballroom North

Sponsored by Aerospace and Electronic Systems Group

Avionics Systems for Rotary Wing Aircraft

Chairman: H. P. Gates, Jr., Asst. for Communications & Avionics Systems, Office of the Assistant Secretary of the Army (R & D), Washington, D.C.

The burgeoning use of helicopters in both military and civilian applications has exposed unique operational requirements, prompted new avionics invention, and opened novel avenues of thought. This session on avionics systems for rotary wing aircraft is keynoted by discussion of the unusual constraints imposed upon system and hardware design by the unique characteristics of the flying machine: its predominantly low-altitude operation; the rotary wing itself, its effect on the performance of the avionics system, and its potential utility as a part of the antenna system; the limited capacity of the aircraft and the consequent urgency for application of microelectronics; and the unusual flying characteristics of the chopper and the consequent new demands placed upon flight control, navigation, approach, and landing systems.

8.1 Avionics for Rotary Wing Aircraft, *Col. L. G. Callahan, Jr., Director, Avionics Lab. Fort Monmouth, N.J.*
The background material presented justifies the treatment of rotary wing avionics as a unique and separate technological entity. Key problem areas are identified and the concept of an Integrated Ground/Airborne Avionics System (IGAAS) is presented as a potential solution. The desirability of "graceful degradation" is discussed in terms of past, current, and future capabilities.

8.2 Airborne Systems, *E. J. Durbin, Dept. of Aerospace and Mechanical Sciences, Princeton Univ., N.J.; Teck Wilson, Vice Pres., Teledyne Systems Co., Hawthorne, Calif.; Seymour Greenspan, Technical Area Chief, Avionics Lab., U.S. Army Electronic Comm., Ft. Monmouth, N.J.*
Among the unique characteristics of rotary wing aircraft that impose a requirement for specialized avionics equipments are: large dynamic speed range, inherent instability, physical and electrical restrictions caused by the rotor(s), low ground clearance, large range of vibration in frequency and amplitude, acoustic noise, and pilot display requirements. The developmental airborne systems that will cope with these characteristics are discussed in terms of present capabilities, specific problem areas, and proposed system approaches.

8.3 Air Traffic Regulations for Low Performance Aircraft, *Laurence Goldmuntz,* *Pres., Tech. Research Group, Inc., Melville, N.Y.; Charles Grossman, Tech. Area Chief, Avionics Lab., U.S. Army Electronics Comm., Ft. Monmouth, N.J.*

The rapid increase in use of rotary wing aircraft, particularly in the limited-war role, has created unique technical problems. One of the most important functions that must be performed by the Army is the air traffic regulation of high densities of helicopters flying in formation at low altitudes during a large variety of visibility and poor weather conditions. The specific nature of problems that arise is developed, and it is shown why many of the conventional methods of air traffic regulation, collision avoidance, and formation flight are not satisfactory for military use. Some of the work being done to solve these problems is described.

8.4 Helicopter Landing Systems, *G. B. Litchford, Aircraft Systems Consultant, Northport, N.Y.; J. T. Saganowich, Avionics Lab., U.S. Army Electronics Comm., Ft. Monmouth, N.J.*

The general nature of the helicopter IFR landing problem is discussed and the landing system characteristics, which, it is believed, should be achieved if the helicopter is to be adequately served by the system design, are reviewed. Added difficulties brought about by operations in the Army tactical environment are also discussed.

8.5 Rotary Wing Cockpit Instrumentation, *George Yingling, Chief, Systems Integration and Flight Experimentation Branch, Flight Dynamics Lab., Air Force Systems Command, Wright-Patterson AFB, Ohio; George Rowland, Pres., Geo. Rowland Assoc., Inc., Haddonfield, N.J.; Sol. Domeshek, Tech. Area Chief, Avionics Lab., U.S. Army Electronics Comm., Ft. Monmouth, N.J.*

For aviator training and operations under VFR as well as transition and IFR conditions, today's helicopter cockpits are handicapped by fixed wing instruments in configurations that do not take full advantage of research of 20 years. Solutions are discussed toward improved instrumentation systems, predicated on an aviator-oriented, integrated-function, modal display approach to ease training and operations in the helicopter's low-altitude, low-speed, steep-slope world under all visibility conditions.

8.6 Avionics Requirements for Open Water Tactical Missions, *H. S. Oakes, Chief, Systems Design and Development Branch, Sikorsky Aircraft Div. of United Aircraft Corp., Stratford, Conn.*

The distinctive avionics needs of naval rotary wing aircraft are characterized by reviewing the Navy's missions and operating environment. Extended over-water operation and flight in coastal areas are shown to impose their own unusual requirements. Particular Navy missions, such as ASW and minesweeping, dictate the need for specific detection devices and navigation capabilities. Additionally, shipboard operations are shown to introduce special aspects in avionic design—especially in relation to reliability and maintainability.

Panel discussion with audience participation

SESSION 9

Monday 9:30 A.M.–12:00 Noon
New York Hilton, Sutton Ballroom South

Sponsored by Reliability Group

Reliability Design and Testing—Case Studies

Chairman: B. L. Retterer, ARINC Research Corp., Annapolis, Md.

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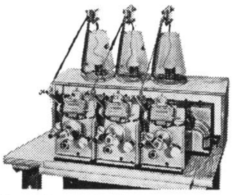
SOME REPRESENTATIVE TYPES ARE SHOWN

MULTIPLE HEAD BOBBIN WINDER
MODEL 314-AMJ3



Front loading. Solid state circuitry. 3 heads illustrated. Each head winds all types of bobbin coils, solenoids, repeater coils or resistors. One operator can run up to 4 heads with a different type coil on each head. Wire size range 18-46AWG.

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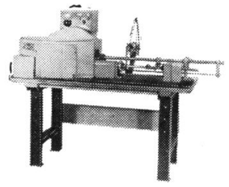

Winds non-linear (variable pitch) or linear wound resistor or potentiometer strips up to 7-3/4" overall winding length. Strips are prevented from flexing or twisting during winding by driven tailstock.

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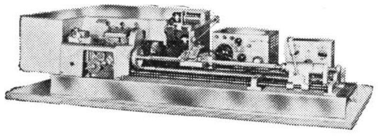

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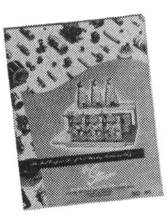

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9.1 The Application of Overstress Testing-to-Failure to Airborne Electronics—A Status Report, *J. J. Bussolini, Chief of Reliability and Maintainability, Grumman Aircraft Engineering Corp., Bethpage, N.Y.*

More than four years of study and actual testing have answered many of the questions that have been raised pertaining to the application of overstress testing to failure as a useful reliability tool in the design of electronic equipment. The results of several applications of this test technique to airborne radar, display, and computer electronics are described. Comparisons of laboratory and flight data are presented to illustrate the validity of the test method. Multiple-source supply evaluation is discussed, including a case history. Of major significance is the presentation of a measured stress–time relationship equating environmental safety margin to MTBF.

9.2 Rules for Applying Error-Correcting Codes to Computers, *H. D. Goldman, Engineering Science Dept., Hofstra Univ., Hempstead, N.Y.*

Error-correcting codes have been previously suggested as a way of improving the reliability of digital computers, and several isolated individual studies of this problem have already appeared in the literature. A mathematical study is presented that shows not only how and when coding should be applied in individual cases, but which also leads one to a better understanding of the general problem. The codes considered are the Bose–Chaudhuri (cyclic) codes and multierror decoding is accomplished by Massey's threshold decoding technique. The most surprising result is that single-error correction gives a better reliability increase than multierror correction not only because less extra equipment is needed but also because it is more efficiently used.

9.3 A Method for Predicting System Downtime, *E. J. Muth, Consulting Engineer, General Electric Co., Daytona Beach, Fla.*

An important figure of merit of a system consisting of repairable components is its cumulative downtime during a prescribed operating period. A method is presented that finds the probability distribution of the system's cumulative downtime from the repair rates and the failure rates of its components. This method has been implemented in a digital computer program and is being used to predict the performance of spacecraft checkout systems.

9.4 X-Ray Vidicon Analysis of Microelectronic Devices, *H. F. Padden, J. J. Lombardi, Jr., Grumman Aircraft Engineering Corp., Bethpage, N.Y.*

Use of X-ray vidicon analysis (television radiography) for screening of microelectronic devices reveals a wide range of low-reliability physical situations within a test time of only seconds per device. The technique provides a dynamic, magnified, internal view of the device for nondestructive examinations. Based on this technique, 25 separate rejection criteria have been established for Grumman microelectronic device specifications.

SESSION 10

Monday 2:00-4:30 P.M.
New York Hilton, Gramercy Suite

Sponsored by Research Committee and Education Group

The Impact of Electronic Techniques on Education

Chairman: W. G. Worcester, Dean of Engineering, Virginia Polytechnic Institute, Blacksburg, Va.

Almost every aspect of society—except education—has been revolutionized during the past 50 years through utilization of technology.

This session focuses attention on: (1) the educational problems generated by the exponential growth of knowledge; (2) what has been done in the development of devices and systems to improve education; (3) effective means of utilizing known technology for the next decade; and (4) long-range future possibilities, with emphasis on needed research in fields such as electronics, psychology, neurology, physiology, and information processing, and cross-linkages that must be developed among these fields to achieve full benefit of electronic aids to education.

10.1 Education—Technology's Stepchild, *J. G. Truxal, Vice Pres. for Educational Development, Polytechnic Institute of Brooklyn, N.Y.*

A very simple mathematical model demonstrates that current changes in engineering education result in sharp increases in net cost per student. If this trend is to be reversed while the quality is retained or improved, the conventional lecture–recitation–laboratory pattern of instruction must be modified to permit improved interaction of students with distinguished faculty. The urgency for such a reorientation of educational procedures with the increased utilization of modern technology is augmented by the growing role of special programs and the developing understanding of the learning process.

The technological advances of primary interest include computer time sharing, remote duplication, information retrieval systems, computer-guided laboratory work, and computer-generated graphics. The utilization of these technical developments in a curriculum designed to meet the needs of modern engineering represents the challenge facing engineering education.

10.2 The Student–Machine Interface in Instruction, *Robert Glaser, W. W. Ramage, Univ. of Pittsburgh, Pa.*

Most formal learning is accomplished by acquiring information through one or more of the principal sensory channels of sight, hearing, and touch, and by responding to this information through verbal and motor channels. The effectiveness of the learning process is related to the manner in which these channels can be utilized and related to each other with respect to particular subject-matter tasks and learning requirements.

The present state of the art of devices used with these channels is briefly reviewed, and current developments and directions are discussed. The significance of sophisticated equipment such as computers to control and augment the functions of these devices is discussed and the implications of computer-based instructional systems on the design of these interface devices is indicated.

10.3 The Key Educational Problems Posed by Advancing Technology, *W. B. Shockley, Prof. of Engineering Science, Stanford Univ., Calif., and Executive Consultant, Bell Telephone Labs., Inc., Murray Hill, N.J.*

10.4 Behavioral Engineering and Education Technology, *Israel Goldiamond, Director, Institute of Behavioral Research, Silver Spring, Md.*

SESSION 11

Monday 2:00–4:30 P.M.
New York Hilton, Murray Hill Suite A

Sponsored by Stochastic Systems Committee of the Automatic Control Group

Plant Optimization and Statistical Filtering

Chairman: H. J. Kushner, Div. of Applied Mathematics, Brown Univ., Providence, R.I.

Three important topics in filtering and estimation are discussed. The papers are partly tutorial and include much interesting information that is either new or not generally available. The first paper presents an analysis of the computationally important recursive schemes for nonlinear discrete-time filtering. Various recursive schemes for estimating a vector parameter θ, given observations $F_n(\theta) +$ noise, are analyzed and numerical results, illuminating the theoretical componsors, are presented.

The second paper considers the problem of sequentially adjusting parameters of an incompletely known plant in order experimentally to optimize a performance index. A number of useful methods, more popular in chemical than electrical engineering, are discussed. Even in the absence of observation noise, the problem of sequential adjustment can be quite difficult, since the plant is not completely known.

The third paper investigates problems in the development of a useful linear model of a plant (in particular, certain chemical plants) from real operating data. Various practical aspects of the model are discussed, e.g., effects of nonlinearities, nonwhite noise (which must be accounted for), types of models, etc. The modeling procedure has yielded an effective predictor in some real chemical plants.

11.1 Nonlinear Regression and Stochastic Approximation, *Arthur Albert, ARCON, Wakefield, Mass.*

Observations are made on a time series, the nth observation being of the form $Y_n = F_n(\theta) + W_n$, where $F_n(\cdot)$ is a vector valued function of a vector variable and W_n is noise. θ is not known and is to be estimated from the data via a recursion of the form

$$\theta_n + 1 = \theta_n + A_n[Y_n - F_n(\theta_n)]$$

The matrices, A_n, are called "gains" and crucially affect the convergence properties of such schemes. Such schemes are examined from the analytic viewpoint. Conditions are presented under which such schemes are sensible and under which they are not, and the dogma is supported with theorems and Monte Carlo data. A principal result is that other gains may work when linearized Kalman–Bucy filters fail.

11.2 Identification for Control Purposes, *J. H. Eaton, Director, Control and Dynamical Systems Lab., International Business Machines Corp., San Jose, Calif.*

A computational procedure is developed for estimating coefficients in a difference equation assumed to characterize a process and its disturbances. The procedure can be used on normal process operating data and does not require any special test to be performed. The problem is approached as one of finding coefficients in a predictor that minimize the one-step-ahead prediction error in the mean-square sense. This formulation can be shown to yield the maximum likelihood estimate under fairly broad conditions.

11.3 Direct Optimization: A Review, *D. J. Wilde, Dept. of Chemical Engineering, Stanford Univ., Calif.*

Direct optimization (or optimum-seeking) methods use direct observations to guide the search for the optimum value of a given objective function.

One may wish to find the optimum value of some objective function by making direct observations of it at several points. Direct optimization techniques, which use accumulated information to locate new observations and guide the search for the optimum, are described and compared.

SESSION 12

Monday 2:00–4:30 P.M.
New York Hilton, Murray Hill Suite B

Sponsored by Communication System Disciplines Committee of the Communication Technology Group

System Interfaces for Global Communications

Chairman: W. H. Forster, International Telephone and Telegraph Corp., New York, N.Y.

Panel Discussion

The increasing requirements for interconnecting various long-distance transmission media in schemes for which they were never originally intended or designed has produced serious problems of compatability of equipments and transmission standards as well as the need for upgrading these systems to meet the new user requirements.

In particular, the international interface between indigenous systems, including mobile and avionic subscribers, and the global networks exemplified by the tie-in between two countries and a particular global network has flagged the need for immediate attention to this crucial problem. The transfer of information by digital functions is considered as the primary signaling means; however, attention is given to the analog signals currently more common. Domestic and provincial interests must be relaxed and directed toward developing early and effective solutions.

The panelists explore the myriad problems in depth, covering properties and demands of global systems including satellite communications systems, submarine cable, indigenous systems, standards against which engineering designs are established, the level of coordination being exercised, the data rates in terms of quality required and achieved, and the projected growth requirements, all with an overview that keeps in mind the extent to which existing equipment will be supplanted by newer designs specifically tailored to the global integration concept for digital traffic. Switching is considered in terms of the implications of completely automated digital switching in contrast to manual analog switching and intermediate hybrid types.

Specifically, the panelists, with international representation, cover the following areas: (1) coordination activity directed toward worldwide standards; (2) military global networks; (3) the interface between global and military networks; (4) civilian national networks, including mobile communications; (5) data rate and reliability requirements for global transfer in terms of the basic properties of the various tandem channels; (6) satellite communications in global networks, including mobile and avionic applications; and (7) interconnecting tactical and strategic networks.

An opportunity is provided for the audience to direct questions to the panelists to elicit information required by the engineering community to help in the solution of the problems cited.

Coordination Activity Directed Toward Worldwide Standards, *C. R. Williamson, Asst. Vice Pres., American Telephone and Telegraph Co., New York, N.Y.*

Military Global Networks, *Brig. Gen. J. B. James, Deputy Commanding General, U.S. Army Strategic Command, Washington, D.C.*

Military communications networks represent an assemblage of the most complex and intricately interfaced facilities existing in the world today. These networks integrate into a homogeneous operation not only military and commercial, but also foreign and domestic, equipment and facilities. Interface problems are varied and imposing, but are being resolved through organized efforts of the military, industry, and professional and standards groups.

The Interface Between Global and Military Networks, *Robert Bright, Director, Government Command Project, Western Electric Co., New York, N.Y.*

Civilian West European Fixed and Mobile Communications Related to Military Requirements, *Gen. Edmond Combaux, Le Materiel Telephonique, Boulogne-Billancourt, France*

Data Rates and Reliability Requirements for Global Transfer in Terms of the Basic Properties of the Various Tandem Channels, *Steven Sussmann, Director of Research, Adcom, Inc., Cambridge, Mass.*

Satellite Communications in Global Networks Including Mobile and Avionic Applications, *S. P. Brown, U.S. Army Satellite Command Agency, Fort Monmouth, N.J.*

Interconnecting Tactical and Strategic Networks, *Lorend Diedrickson, Office of U.S. Project Manager, Project MALLARD, Fort Monmouth, N.J.*

SESSION 13

Monday 2:00–4:30 P.M.
New York Hilton, Nassau Suite

Sponsored by Cybernetics Committee of the Systems Science and Cybernetics Group

Principles of Advanced Information Processing

Chairman: H. L. Oestreicher, Aerospace Medical Research Labs., Wright-Patterson Air Force Base, Ohio

In contrast to the state of affairs some 150 years ago, when mechanical work was done primarily by animals and human beings, machines perform today the bulk of heavy mechanical chores much better and much more efficiently than living organisms ever did. With respect to information processing, things are quite different and in many respects living organisms are at present, particularly in problems of higher complexity, by far superior to existing computers and automata, presenting a challenge to the scientist and engineer. Great progress has been made in the development of "intelligent" machinery during the past two decades, and in this interdisciplinary session five speakers discuss problems and recent research in "advanced information processing," covering topics that range from basic considerations about the living brain, the modeling of nervous systems and some of their remarkable abilities by neural networks and computer programs, to theoretical work on a specific important problem in pattern recognition, and finally to the ultimate test of all theories, a report on a hardware model of an "intelligent" automaton.

13.1 The Brain of Yesterday and Today, *W. R. Ashby, Dept. of Electrical Engineering, Univ. of Illinois, Urbana*

The Greek philosophers thought the brain was mucus waiting to come down the nose. The medieval schoolmen thought that everything went on in the mind, the brain being negligible. The early physiologists thought of the brain as basically inert, becoming active only when prodded by a stimulus.

Because ideas of this type are still far too prevalent in our ways of thinking about the brain, major changes are outlined that must be made if we are to move to a wholly modern way of thinking about the brain.

13.2 Information Processing in Highly Damped Neural Nets, *E. M. Harth, Univ. of Syracuse, N.Y.*

Cognitive functions are sought in a homogeneous, randomly connected net of neuron-like elements. Information is assumed to be contained in the instantaneous states of the system, which specify the firing states (OFF or ON) of each neuron in the net. The hypothesis of synaptic facilitation is assumed to be the basis of learning and memory. Due to the high degree of damping no reverberations occur in the net. However, close analogies can be found between the performance of the net and known association functions of the cerebral cortex, among them various types of conditioned reflexes. The data are obtained by a combination of mathematical analysis and computer simulation.

13.3 On the Applicability of Wiener's Canonical Expansions, *D. B. Brick, Information Research Associates, Lexington, Mass.*

13.4 On the Complexity of Pattern Recognition, I—The Complexity of Patterns, *L. N. Kanal, T. J. Harley, Jr., Philco-Ford Corp., Blue Bell, Pa.*

Measures of pattern complexity relevant to the performance of classification networks are examined. These measures are based on formal concepts arising in vector spaces and information theory; they are consistent with intuitive concepts of pattern complexity and recently reported observations on image perception by infants.

13.5 An Intelligent Automaton, *C. A. Rosen, N. J. Nilsson, Stanford Research Institute, Menlo Park, Calif.*

A mobile vehicle equipped with television camera and with tactile, range-finding, and acoustic sensors is under construction. It will be remotely controlled by a SDS 940 computer.

Software and special-purpose hardware will include a pattern-recognition system for simple three-dimensional objects, means for investigating and storing models of the environment, a set of problem-solving routines, and finally an executive system for integrating all functions.

SESSION 14

Monday 2:00–4:30 P.M.
New York Hilton, Regent Room

Sponsored by Systems Science and Cybernetics Group

Systems with On-Line Computer Control

Chairman: L. F. Lewis, General Electric Co., Schenectady, N.Y.

Each of the papers in this session describes an application in which a digital computer functions in some manner as part of a closed-loop control system. From the computation of the simple single-loop algorithm as performed by the DDC computer (but repeated swiftly for many such loops), to the large-scale complex problem solved for control of the nation's air spaces, the computer exists as an element in a dynamic system.

Four papers span the range of computer control in today's state of the art. Whereas the same central processing unit may perform important auxiliary functions of data acquisition, data presentation, or feed-forward (programming) control, the emphasis here is on the creation within the feedback loop itself of simple or complex transfer functions by the application of the digital computer.

Each application is a study in systems engineering.

14.1 Direct Digital Control—A Total Systems Approach, *S. R. B. Opie, General Electric Co., Process Computer Business Section, Phoenix, Ariz.*

This paper discusses a building-block approach to the problem of applying direct digital control economically to widely differing processes. This approach allows each case to be handled individually, but without treating it as a new system design project.

14.2 Testing the NORAD Command and Control System Man-Machine Interface, *R. T. Stevens, The Mitre Corp., Bailey's Crossroads, Va.*

Closed-loop testing of the NORAD Command and Control System's ability to perform its assigned task—providing support for CINCNORAD in directing the air defense of North America—required special techniques since men were an integral part of the feed back loop. The system test design and results are treated.

14.3 Integration of a Digital Computer into a Maneuvering Re-entry Vehicle, *H. J. Most, Manager, Digital Computer Technology & Programming; R. S. Davis, Systems Engineer, Re-entry Systems Dept., General Electric Co., Valley Forge, Pa.*

Advances in digital computer technology have resulted in airborne devices that are capable of real-time vehicle control as well as general-purpose on-board calculations. The purpose of this paper is to detail the systems approach to the selection and integration of such a computer as an in-line component of a control system for a maneuvering reentry vehicle.

14.4 National Airspace System Enroute, *F. K. Seward, Operational Programming, IBM-NAFEC, Atlantic City, N.J.*

The National Airspace System, as conceived by the Federal Aviation Agency, will provide advanced air traffic control capabilities in the 1970s through the use of real-time computing systems. A description is presented of the major elements of the NAS Enroute Stage A system: the IBM 9020 Data Processing System (a System/360-based multiprocessor), the NAS Air Traffic Control peripheral input/output equipment, and the Enroute Operational Program.

SESSION 15

Monday 2:00–4:30 P.M.
New York Hilton, Rhinelander Gallery North

Sponsored by Electron Devices Group

Solid-State Devices Frontiers

Chairman: J. M. Early, Bell Telephone Labs., Inc., Allentown, Pa.

This session of four invited presentations has been organized so as to present a picture of the recent history and present prospects of four important technological frontiers in solid-state electronics. Because digital integrated circuits will be covered so thoroughly in other sessions of the convention, no survey of this subject is included here.

The authors of all of the papers are actively involved in research and development in their respective areas. The presentations on linear integrated circuits, field-effect devices, and microwave power sources are aimed not only at indicating what is currently feasible, but at a tutorial introduction to current problems and limitations, plus an indication of future advances.

The paper on secondary breakdowns is intended to serve both as an introduction to this phenomenon, which is becoming of increasing importance as device performance is improved, and to give some indications as to what can be done about secondary breakdown.

15.1 Linear Integrated Circuits: Today and Tomorrow, *R. S. Pepper, Director of Integrated Circuit Development, Sprague Electric Co., North Adams, Mass.*

First, today's integrated device and process technology capabilities are covered briefly. Next, design procedures characteristic of linear integrated circuits are discussed and illustrated by examples from available circuits, and factors influencing cost and performance are examined. Finally, tomorrow's system, circuit, device, and technology capabilities are explored.

15.2 The Future Role of Field-Effect Devices in Electronics, *F. P. Heiman, RCA Labs., Princeton, N.J.*

The characteristics of junction-gate and insulated-gate field-effect transistors are discussed and present-day applications for these devices are reviewed. An examination of the ultimate frequency response, minimum power, and minimum size leads to future applications in digital and analogue integrated circuits, including thin-film transistors, monolithic silicon circuits, and silicon-on-sapphire circuits.

15.3 Secondary Breakdowns in Power Transistors and Circuits, *W. C. Steffe, Manager, Device Development, Fairchild Semiconductor Research & Development Labs., Palo Alto, Calif.*

In the active operating region of power transistors, lateral thermal instability causing current constriction into a small hot spot is responsible for device failure. In the avalanche region several failure modes associated with very short time constants have been proposed. By appropriate choice of device structure and circuit configuration equipment failure can be avoided.

15.4 New Solid-State Devices for Microwave Power Generation, *M. R. Barber, Bell Telephone Labs., Inc., Murray Hill, N.J.*

The performance of microwave oscillators using avalanche diodes, bulk gallium arsenide devices, and transistors is compared with that obtainable from reflex klystrons. Computer-generated movies are used to illustrate some of the physical phenomena involved. Techniques for optimizing circuits to obtain low noise, tunability, high power, and efficiency are discussed.

SESSION 16

Monday 2:00–4:30 P.M.
New York Hilton, Regent Room

Sponsored by Microwave Theory and Techniques Group

Microwave Miniaturization— A Progress Report

Chairman: Carl Blake, Group Leader, Array Radars Group, M.I.T. Lincoln Lab., Lexington, Mass.

Rapid advances through the use of new materials and technologies in reducing the size of microwave components and assemblies are discussed. This topic is of major significance to system designers in many disciplines (communications, guidance, navigation, tracking, reconnaissance, etc.), as well as to all technical personnel directly associated with the microwave industry.

The subject matter is treated in a tutorial manner to acquaint those not actively pursuing microwave miniaturization with the trends in this field that are expected to have a fundamental impact on both future system designs and the microwave component industry itself.

16.1 Microwave Semiconductor Devices, *R. R. Webster, Texas Instruments Inc., Dallas, Tex.*

The state of the art is presented in semiconductor device technology and performance: transistor oscillators and amplifiers, diode mixers, varactor and p-i-n switches; avalanche and Gunn effect devices are considered briefly. Some of the devices exist in monolithic integrated circuit form, and possibilities and limitations are discussed.

16.2 Microwave Hybrid Integrated Circuits, *J. E. Dalley, Bell Telephone Labs., Inc., Reading, Pa.*

Microwave circuits utilizing thin-film components deposited on hard substrates with appliqued active devices are now being produced and used. They offer improved performance at reduced cost and, in some cases, smaller size. A tutorial survey emphasizing the circuit design aspects and applications of several circuits is presented.

16.3 Planar Ferrite Devices for Microwave Integrated Circuitry, *H. A. Hair, Syracuse Univ. Research Corp., Special Projects Lab., Syracuse, N.Y.*

Passive and controllable ferrite devices are required in a geometry suitable for incorporation in integrated microwave subsystems. These devices should be compatible with integrated semiconductor components, and with photo-etch techniques that allow simple realization of complex circuitry. The progress of the development of such ferrite devices is reviewed.

16.4 Recent Advancements in Microwave Integrated Circuits Combining Semiconductor and Ferrimagnetic Elements, *J. C. Hoover, G. A. Foggiato, R. W. Peter, L. B. Valdes, Watkins-Johnson Co., Palo Alto, Calif.*

Recent advancements in utilizing ferrimagnetic elements, in particular YIG spheres, as resonators and tuning elements in conjunction with semiconductor devices in microwave hybrid integrated circuits are described. In such applications the YIG sphere provides an inherently small size tunable resonator, approaching the dimensions of the semiconductor element and surpassing conventional resonators in its *Q* factor.

SESSION 17

Monday 2:00–4:30 P.M.
New York Hilton, Sutton Ballroom North

Sponsored by Aerospace and Electronic Systems Group

Integrated Avionics— Today and Tomorrow

Chairman: T. F. Rogers, Deputy Director of Defense, Research & Engineering, Electronics and Information Systems, Dept. of Defense, Washington, D.C.

17.1 Why Integrated Avionics? *W. P. Beese, Senior Staff Engineer, TRW Systems, Redondo Beach, Calif.*

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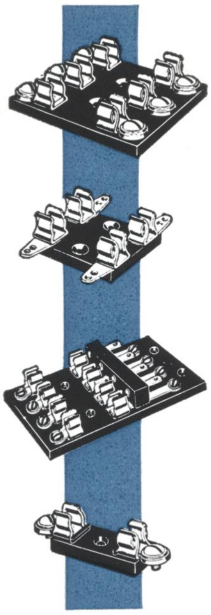

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The demands for additional avionics equipment continue to grow. The space available does not. System designers have been forced to think of the entire system (including ground support) as an entity. Heretofore, system responsibility was delegated to each of the various technical disciplines to form a loose confederation of independent systems.

17.2 Total Weapon Systems Reliability Through Integrated Avionics, *J. Cohen, W. H. Barnard, E-2B Program Managers, Grumman Aircraft Engineering Corp., Bethpage, N.Y.*

17.3 Is "Integrated" Integrated? *Harry Davis, Deputy for Research, Office of the Assistant Secretary of the Air Force (R&D), Washington, D.C.*

The trend toward integration in many things, avionics being one of them, is a strong one because of the many obvious benefits. Over the years, there have been many attempts at integration of avionics, none with complete success. There are many reasons why failure has been more characteristic of past efforts than success. Among these are: (1) the problems of coordinating the development of the system, both hardware and software, when many design engineers are involved; (2) the lack of a reliable and viable display system for integrated avionics; (3) the compounding of the problem of assuring reliability and "graceful degradation" in an integrated system; (4) the nature of the tasks to be accomplished, which often dictate widely different radio frequencies, modulations processing, and displays; and most important (5) the fact that an aircraft's avionics system cannot be designed without taking into account the constraints of a ground environment that evolved rather haphazardly, without the benefit of a well-conceived total plan.

17.4 IHAS-ILAAS: A Status Report on Avionics Systems Integration, *L. S. Guarino, IHAS-ILAAS Technical Manager, U.S. Naval Air Development Center, Johnsville, Warminster, Pa.*

The status of IHAS and ILAAS as examples of integrated avionics systems is discussed. The design philosophy of these systems is explained. The avionic system approach criteria to achieve commonality are exemplified for several applications. The role of the technical manager in the acquisition of integrated avionics is also covered.

17.5 Integrated Avionics: Management's Challenge, *Capt. A. J. Stanziano, Director, Avionics Div., Air Systems Command, Department of the Navy, Washington, D.C.*

Avionics complexity, concurrent with technological advances, has reached the point where application of the systems approach and the quantification of systems effectiveness are mandatory. The influence of these considerations and systems integration on the management of avionics systems development and the organizational structure required for such management is discussed.

Panel discussion with audience participation

SESSION 18

Monday 2:00–4:30 P.M.
New York Hilton, Sutton Ballroom South

Sponsored by Engineering in Medicine and Biology Group

Engineering in Surgery

Chairman: Lester Goodman, Chief, Biomedical Engineering & Instrumentation Branch, National Institutes of Health, Bethesda, Md.

This session is planned to show the vital part that engineering in medicine and biology plays in technology and the life sciences. The four papers selected illustrate the challenges that confront electrical and electronics engineers in the surgical arena, and emphasize practical solutions to complex, literally real-life problems. Attention is called to the opportunities that await the engineer who seeks an exciting and rewarding career in direct service to his fellows and, thus, to himself.

18.1 Effects of Laser Energy on Living Tissue, *G. C. Riggle, Biomedical Engineering & Instrumentation Branch, Div. of Research Services; R. C. Hoye, Surgery Branch, National Cancer Institute, National Institutes of Health, Bethesda, Md.*

Data developed from animal experiments determined the amount of laser energy required to insure 90 percent probability of tumor destruction when exposed to 3 × 10^{14} Hz neodymium. Some viable cells were observed when post-lasered areas were microscopically examined. An engineering hypothesis of these phenomena is suggested and its practical importance to laser cancer surgery discussed.

18.2 An Electronic Heart Motion Tracking System, *W. H. Schuette, Biotronex Lab., Inc., Silver Spring, Md.; A. L. Simon, National Institutes of Health, Bethesda, Md.*

A new device for accurate recording of cardiac motion is described, using "track while scan" techniques on the video signals available from televised fluoroscopy. Second-order tracking loops yield close to optimum accuracy from the data available since nonlinearities in the discriminator are nulled out by the closed-loop system.

18.3 Postoperative Monitoring, *F. John Lewis, M.D., John E. Jacobs, Northwestern Univ., Evanston, Ill.*

The postoperative patient suffers from infrequent and incomplete monitoring. We are attempting to design, build, and test a monitoring system that employs computer and engineering technology. The system measures pertinent physiological variables, subjects them to the necessary computations, and analyzes the results immediately to obtain an on-line report.

18.4 A Method for Identifying Brain Structures During Parkinson Surgery, *Anthony Sances, Jr., Director of Biomedical Engineering, Marquette Univ., Milwaukee, Wis.; S. J. Larson, M.D., Chairman, Dept. of Neurosurgery, Marquette Univ. School of Medicine, Milwaukee, Wis.; A. S. Wilson, Asst. Prof. of Psychology, Marquette Univ., Wood, Wis.*

A method for recording electrophysiological potentials from awake patients during stereotaxic surgery is discussed. Peripheral and brain stimulation are used to evoke scalp and depth responses. The evoked potentials are recorded and the waveform configurations correlated with radiographic data to identify various brain structures.

SESSION 19

Tuesday 9:00–11:30 A.M.
New York Hilton, Gramercy Suite

Sponsored by Metal Industry Committee of the Industry and General Applications Group

Control Techniques in the Steel Industry

Chairman: W. H. Wigington, Jr., Morgan Construction Co., Worcester, Mass.

In the steel mills of today, control techniques and applications are constantly being refined and expanded. This session presents timely typical examples of this philosophy and practice; and includes the reactions of, and demands on, users of this class of equipment.

19.1 Speed Control of the Finishing Train of Hot Bar Mill, *R. M. Brenza, Dept. of Electrical Engineering, Univ. of Pittsburgh, Pa., and Consultant to Duquesne Electric and Mfg. Co., Pittsburgh, Pa.*

The design and operation of a speed control system for the finishing train of a hot bar mill are described. The system is designed on an individual stand basis with no coupling between the stands. Since a pacer stand is not employed, the speed of each stand must be highly regulated during impact loading. A very-high-gain system is needed to achieve the required regulation and response time. The gain is obtained by the use of an SCR amplifier as a preamplifier in the Ward-Leonard System. The overall system is described as well as the various feedback paths and their functions. This includes a description of the high-speed bistable amplifiers that are used for current-limit protection. The results of an analog computer simulation of the process illustrates the variations of the system variables during imput loading. Test curves taken during start-up are also included.

19.2 Direct Digital Control of a Reversing Slabbing Mill, *L. R. Berry, T. H. Bloodworth, Process Electrical Systems, Allis-Chalmers Mfg. Co., Milwaukee, Wis.*

The use is described of a single computer, time shared to provide direct digital control of a reversing slabbing mill with a remote edger. Complete automatic control is provided for

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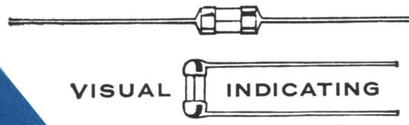

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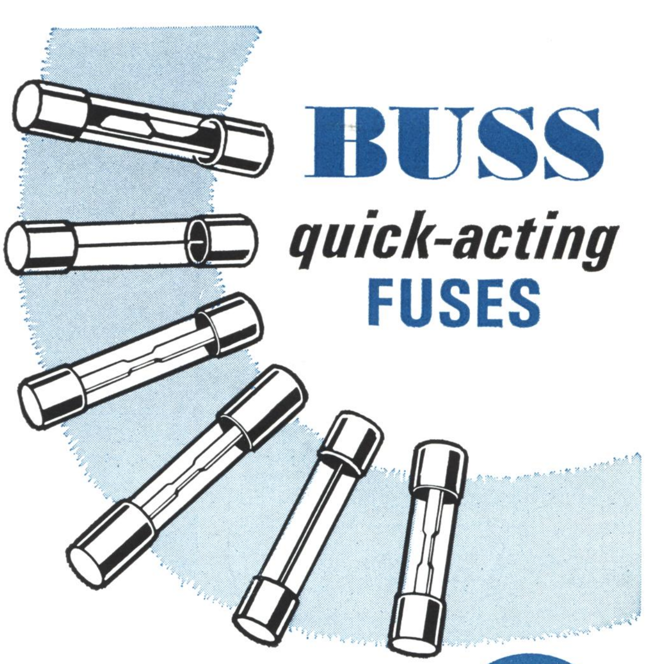

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19.3 Computerizing a Cold Rolling Mill, *C. E. Trott, Jr., R. E. Slater, Industrial Control Systems, Electric Boat Div. of General Dynamics Corp., Groton, Conn.*

A discussion is presented of techniques for applying automatic computing devices to cold rolling mills, in conjunction with high-response electrohydraulic wedge screwdown actuators, in the areas of output product gauge control, mill prerolling setup, roll pass sequencing for reversing mills, and system protection from faults and overloads.

19.4 A Steel Mill Engineer's Viewpoint of Solid-State Electric Equipment, *G. C. Gingher, Jr., Electrical Dept., Bethlehem Steel Corp., Sparrows Point, Md.*

Due to the competitive pressures of today's market, the steel industry has made tremendous capital expenditures for modern equipment in the last several years. This has resulted in a sudden transition to solid-state electric equipment in areas that previously may have had nothing more sophisticated than a constant-potential crane control. Some of the difficulties, as well as the advantages, of the solid-state revolution in mill control are examined from the viewpoint of the steel mill engineer.

SESSION 20

Tuesday 9:00–11:30 A.M.
New York Hilton, Murray Hill Suite A

Sponsored by Automatic Control Group

Applications of Digital Computers in Control

Chairman: J. B. Lewis, Pennsylvania State Univ., State College, Pa.

Control systems that utilize a digital computer as an element in the control loop are being designed and installed in a variety of industries. This session considers some of the aspects of direct digital control: development of control algorithms, design procedures to facilitate on-line adjustment, plant identification, and conversion equipment for accepting analog input signals and supplying analog output signals. Test results and hardware are described as well as new theoretical developments for the design of control systems.

20.1 Minimum Norm Control of Discrete Systems, *C. H. Wells, Office Project Manager, Nike X, Redstone Arsenal, Huntsville, Ala.*

Discrete stationary linear or nonlinear systems with quadratic performance indices are studied. Measurable state systems are controlled using the properties of the matrix pseudoinverse. A sequential algorithm is developed for the computation of the pseudoinverse of any matrix. Input amplitude constraints are considered using an iterative technique.

Nonmeasurable state linear systems are controlled and identified sequentially using the pseudoinverse algorithm. It is shown that an nth order system may be completely identified and driven toward a desired output in at most $2n$ samples.

For overdetermined sets of linear equations, the pseudoinverse algorithm is shown to be equivalent to the discrete linear filter of Kalman.

20.2 A Tunable Design Procedure for DDC, *R. W. Koepcke, W. G. Tuel, Jr., International Business Machines Corp., San Jose, Calif.*

The building of discrete controllers consists of off-line model construction and controller design followed by on-line adjustment. In chemical processes, the latter is of dominating importance, and yet much of conventional theory tends to ignore it to such an extent that tuning procedures are obscured. This problem is considered, and a design procedure presented whose philosophical orientation is to sacrifice any mathematical nicety in model building and controller design that does not contribute to the total integrated problem of modeling, designing, and particularly tuning.

20.3 Maximum Likelihood Estimation of Rational Transfer Function Parameters, *A. E. Rogers, Dept. of Statistics and Computer Science, Univ. of Delaware, Newark; K. Steiglitz, Dept. of Electrical Engineering, Princeton Univ., N.J.*

The problem of estimating unknown transfer function parameters in the presence of Gaussian noise with unknown correlation is considered. It is assumed that a rational sampled-data model of fixed order is appropriate and that finite normal operating records of the input and noise-corrupted output signals are available. Following work of Klein, Astrom, and Mayne, the likelihood function is generated from the data by filtering operations. The maximum likelihood criterion then leads to nonlinear regression equations in the unknown parameters. Some algorithms for solution and some computational experiments are described.

20.4 CESSAM: Conversion Equipment System, Surface-to-Air Missile, *K. S. Bonwit, The Johns Hopkins Univ., Applied Physics Lab., Silver Spring, Md.; R. E. Rasche, Information & Communication Div., Sperry Gyroscope Co., Great Neck, N.Y.*

The CESSAM is a militarized solid-state A/D and D/A converter that allows a digital computer to control a shipboard analog fire control system. Synchro, resolver, ac, and dc signals may be accommodated at the input and produced at the output. All signal-processing circuits are of modular construction, and integrated circuits are used extensively.

20.5 An Application of Optimal Control Theory to the Control of Color on the Paper Machine, *P. R. Belanger, Foxboro Co., Foxboro, Mass.*

A brief discussion is given of the nature of color, its quantitative formulations, and its measurement. A model is developed for a small-scale paper machine equipped for continuous coloring. The model is based both on theoretical analysis and experimental results. For small deviations, the model has three inputs and three outputs, coupled through a gain matrix. The dynamics are first order plus time delay.

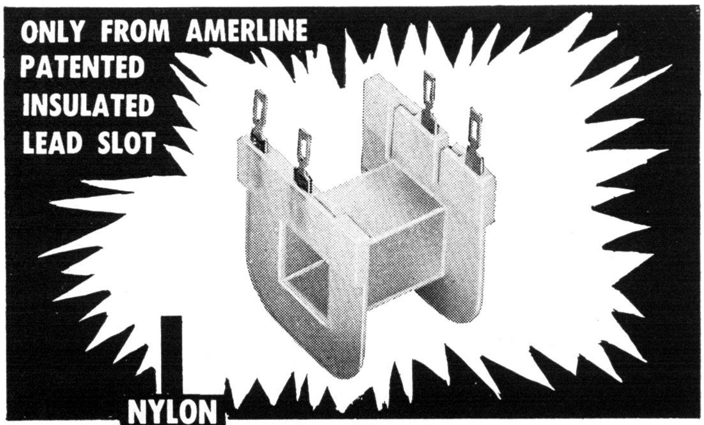
Digital integration is introduced, and an algorithm is developed based on linear optimal control theory. Results of a digital simulation are given, including the effects of parameter variations and sampling rates. Comparisons are made with simulation results using a conventional three-term algorithm.

SESSION 21

Tuesday 9:00–11:30 A.M.
New York Hilton, Murray Hill Suite B

Sponsored by Wire Communication Committee of the Communication Technology Group

Wire Communication I— New Developments in Exchange Transmission



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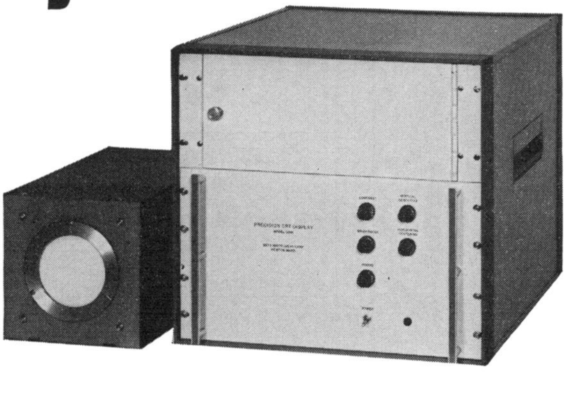

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Chairman: J. N. Petrie, Chief, Trans. Engg., Automatic Electric Co., Northlake, Ill.

The four papers in this session cover new equipment and measurement aspects of subscriber, exchange, and trunk plant.

The first paper describes a method of deriving additional subscriber circuits over existing cable pairs. The effects of temperature variations on exchange loops and trunk plant are described in the second paper, with particular reference to the effect of resistance variations in the engineering of optimum loops.

The last two papers cover measurement techniques; one deals with unbalance attenuation measurements and in the other a new test set for the automatic or manual measurement of transmission levels is described.

21.1 Design and Application of Multichannel Long-Haul Electronic Distribution System, *C. E. Greene, Vice Pres., Engineering, L. Q. Krasin, Pres., PED, Inc., Dallas, Tex.; W. T. Smith, Vice Pres., Superior Cable Corp., Hickory, N.C.*

Equipment designed electronically to derive additional subscriber circuits over existing cable pairs utilizing the latest state of the art of solid-state devices is described. Basically, it is a four-channel system utilizing the copper pair for transmission of carrier and all power required. The range of the equipment is such that it can handle 140-dB loss utilizing three repeaters. The equipment automatically makes all adjustments required for subscriber terminals to be connected along the route to obviate need for any adjustment for personnel making the installation. The equipment provides means of serving one-party, two-party, or up to five-party circuits without any modifications of the basic equipment.

21.2 Field Evaluation of Cable Temperature Effects on Exchange Loop and Trunk Plant, *D. H. Potter, General Telephone Co. of Calif., Pomona*

The effects of outside air temperatures on table resistances become very important when engineering optimum loops for exchange and trunk telephone plants. An engineering evaluation is presented of the results of engineering studies over a one-year period on various lengths and gauge combinations of aerial and underground cables.

21.3 Measurement of Unbalance Attenuation, *L. O. Olson, Western Electric Co., Inc., Lee's Summit, Mo.*

In the telephone industry extensive use is made of balanced transmission circuits and components. One of the principal reasons for the use of balanced circuits is the elimination or reduction of induced noise signals. The degree of balance of the components will, to a large extent, determine its susceptivity to noise signals. The measurement of the degree of balance of these components of a circuit is the major topic discussed.

21.4 Compact Solid-State Automatic Level Measuring Set, *C. B. Crane, Jr., Northeast Electronics Corp., Concord, N.H.*

This set can be used as the far-end equipment for transmission measurements. Connections to this equipment can be made by manual or automatic dialing. The unit can be equipped to provide digital or analog reporting to the interrogating end and can be equipped with a local digital readout.

SESSION 22

Tuesday 9:00–11:30 A.M.
New York Hilton, Nassau Suite

Sponsored by Basic Sciences Committees

The Computer for Basic Research in the Humanities and Behavioral Sciences

Chairman: Ivan Flores, Assoc. Prof. of Electrical Engineering, Stevens Institute of Technology, Hoboken, N.J.

Panel Discussion

The panel will address itself to the feasibility in the not-too-distant future of having the computer serve as a judge in either criminal and/or civil court cases. It is understood that a large amount of research would be required before such an eventuality could be realized; the question is, are difficulties surmountable and is there a gain to be made in the spirit of greater justice.

Some of the issues the panel will examine are: knowledge of precedents, ability to reason legally, evaluation of evidence, acceptance of testimony, emotional factors, humanistic values, variability of human judge, constitutionality of the computer as a judge, effect of computer judge on litigants, procedional aspects with a courtroom.

Take just the factors of emotionality and variability: Who can deny that the judge as human is subject to being angry and moody? Are these factors in favor of human judge or would we not do better to eliminate them?

It is hoped that this panel will have the effect of bringing the issues about computer judges out into the open and encourage further research along these lines.

Irving Kayton, Associate Prof. of Law, George Washington Univ., Washington, D.C.

Judicial Decision Making by Computer—A Goad to Improvement of the Legal Process, *R. N. Freed, Div. Counsel, Computer Control Div., Honeywell Inc., Framingham, Mass.*

Although deficiencies in the present judicial process make computer decision making attractive for its advantages of speed and consistency, large segments of that process have basic qualities, such as imprecision of legal rules, dynamic change of rules, lack of agreement on fact inputs, and presence of unquantifiable but important human values, that appear to defy mechanization. Nevertheless, efforts to achieve such mechanization probably would produce significant improvements in the judicial process generally, similar to benefits secured in other applications studied, and might uncover limited areas amenable to such computer use.

S. P. Sims, Ferguson Personnel Agency, New York, N.Y.

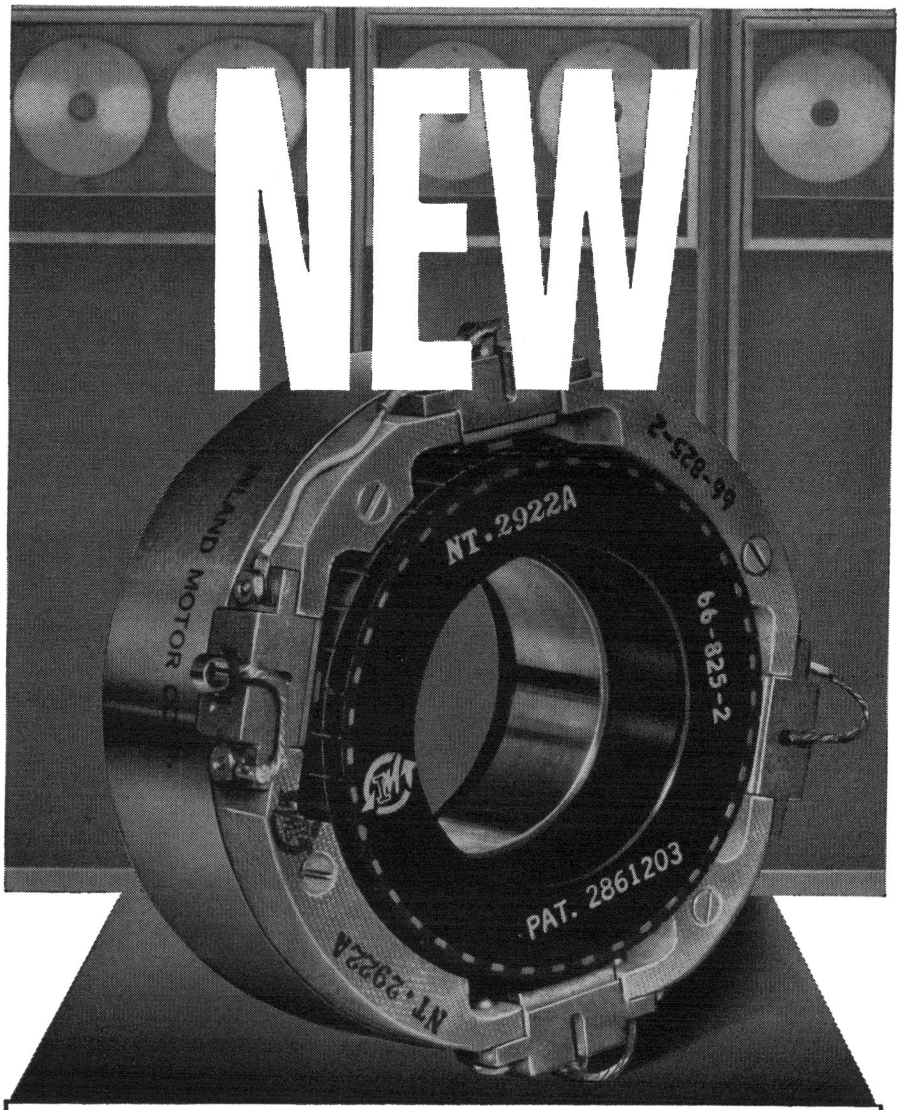
L. E. Allen, Mental Health Institute, Univ. of Michigan, Ann Arbor

The Computer as Prelitigational Judge: The New Technology and Legal Ethics, *A. A. Leban, Asst. Counsel, The Equitable Life Assurance Society of the United States, New York, N.Y.*

Computer-assisted research into the main legal issue of a series of decided appellate cases indicated that the suits had less merit in their inception than manual research actually revealed. Implications of computer-assisted prelitigational searches are examined for potentially fulfilling and enforcing the attorney's ethical obligation to refrain from bringing questionable suits.

The Computer and Analytic Assistance in the Judicial Process, *Fred Kort, Univ. of Connecticut, Storrs*

This presentation is concerned with the use of computers in the analysis of (1) decisions of appellate courts as functions of facts, (2) the combinations of these facts in terms of linear or nonlinear models, and (3) the acceptance or rejection of the facts by appellate courts from lower court records and appellate briefs.



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SESSION 23

Tuesday 9:00–11:30 A.M.
New York Hilton, Regent Room

Sponsored by Circuit Theory Group

State- and n-Variable Realizations and Filter Design

Chairman: R. W. Newcomb, Stanford Electronics Lab., Stanford Univ., Calif.

State-variable methods have led to reformulations and new solutions of network analysis, synthesis, and equivalence problems both in the time and frequency domain. Hand in hand with state-variable techniques, *n*-variable theory has led to the synthesis of transmission-line networks containing lumped reactive elements and incommensurate lines. This session is devoted to various aspects of these theories.

The middle three papers of the session concentrate on new results in the state-variable theory area. That of Tokad and Nordgren considers time-invariant synthesis, while those of DeClaris and Seaks and of Silverman discuss, respectively, analysis and synthesis of time variable systems through the state. The final paper, by Scanlan, reviews the position of *n*-variable theory for distributed circuit design. The paper of Temes and Gyi gives a useful filter design technique while pointing out an area for future state-variable investigations.

23.1 Design of Filters with Arbitrary Passband and Chebyshev Stopband Attenuation, *G. C. Temes, M. Gyi, Ampex Corp., Redwood City, Calif.*
A design technique is presented for the approximation of an arbitrary passband loss characteristics while maintaining an equal-ripple stopband. The passband approximation can be of a maximally flat, least-squares, or equal-ripple type, including the option of a weighting function. The method is applicable to low-pass, high-pass, bandpass, or bandstop networks.

23.2 On the State Model Approach to the Realization of Portless RLC Networks, *J. C. Nordgren, Y. Tokad, Dept. of Electrical Engineering, Michigan State Univ., East Lansing*
A general method is described for decomposing a given *A* matrix into the product of two matrices; one is the direct sum of two positive definite matrices corresponding to the inductive and capacitive networks, and the other is a hybrid matrix that corresponds to a resistive network. By the application of this general method, the necessary and sufficient conditions for the second order *A* matrix to be the *A* matrix of an *R-L-C*, *R-L*, or *R-C* network are established and all possible realizations are tabulated.

23.3 Canonic and State-Variable Characterization of Networks with Variable Elements, *N. DeClaris, R. Saeks, School of Electrical Engineering, Cornell Univ., Ithaca, N.Y.*
It is increasingly clear that network theory must consider classes of systems that contain variable elements. Traditionally they are viewed solely as time-varying networks. In this paper an analysis is presented wherein element variations of the network are treated in an abstract algebraic fashion bypassing the usual analytic difficulties.

The approach is based on a recently developed graph theoretic technique for dealing with controlled sources. The important feature of the analysis is that it emphasizes the linear algebraic structure imposed by the topology of the network. Parameter considerations, linear or nonlinear, enter the formulation only as a final step. Depending on the element variations and/or the topology, the resulting differential equations characterizing the behavior of the network may be linear or nonlinear. In either case the result is a system of first-order differential and algebraic equations in *n* unknowns. Current trends for state-variable techniques are considered in the light of the results presented.

23.4 Stable Realization of Impulse Response Matrices, *L. M. Silverman, Dept. of Electrical Engineering, Univ. of California, Berkeley*
The extent to which the impulse response matrix determines the stability of its realization is examined. In particular, a set of conditions on the impulse response matrix that insure the existence of stable realizations are presented together with a systematic procedure for generating such realizations. In the fixed and periodic cases, these conditions are equivalent to bounded input–bounded output stability.

23.5 Multivariable Network Functions, *S. O. Scanlan, Dept. of Electrical and Electronic Engineering, Univ. of Leeds, England*
Problems involving mixed lumped and (commensurate) distributed network elements, or incommensurate distributed elements may be treated by means of network functions of two or more complex variables. Results on the synthesis of two-variable reactance functions and scattering matrices have been found together with the synthesis of a terminated cascade of incommensurate unit elements, and a cascade of commensurate unit elements terminated in a non-Forster lumped impedance. These results are reviewed and some new results including the case of a cascade of commensurate unit elements with lumped capacitive discontinuities are presented.

SESSION 24

Tuesday 9:00–11:30 A.M.
New York Hilton, Rhinelander Gallery North

Sponsored by Electron Devices Group

The State of the Tube Art

Chairman: M. G. Bodmer, Bell Telephone Labs., Inc., Murray Hill, N.J.

The state of the art of four areas in the field of electron tubes will be discussed, mainly from the points of their applications and future trends.

The papers cover the fields of microwave tubes in phased-array radar transmitters, of gas discharge and solid-state microwave duplexers, of image tubes, and of cathode-ray tubes in computer applications.

24.1 Comparison of Microwave Tubes for Phased-Array Radar Transmitter Application, *L. L. Clampitt, R. A. Handy, M. W. Huse, Microwave & Power Div., Raytheon Co., Waltham, Mass.*
The criteria involved in the selection of transmitter tubes for phased-array radar systems are reviewed and the principal candidates identified. Critical performance parameters for traveling-wave tubes and cross-field amplifiers are examined. Tube-systems problems are reviewed. Several examples of tubes used in array radar applications are cited.

24.2 Solid State Versus Gas Discharge Techniques for Microwave Duplexing, *Gerald Klein, Westinghouse Defense and Space Center, Aerospace Div., Baltimore, Md.*
Various forms of microwave solid-state and gas-discharge devices are evolving to perform the two functions of radar duplexer: (1) switching the antenna between transmitter and receiver; (2) protecting the receiver. The present status of technology is reviewed, with considerations of optimum design for particular applications.

24.3 Modern Image Tubes and Their Applications, *Jay Burns, Northwestern Univ., Dearborn Observatory, Evanston, Ill.*
Principal types of commercially available image tubes will be described and their performance capabilities discussed. Emphasis will be given to a wide variety of representative applications where such tubes are being used successfully. Prospects of future improvements in image-tube performance that may lead to new applications will be examined.

24.4 Computer CRT Applications and Future CRT Requirements, *G. M. Krembs, International Business Machines Corp., Kingston, N.Y.*
Remote inquiry displays, instructional stations, graphic design consoles, large-area projectors, photographic film or paper recorders, and flying-spot optical readers have been designed with CRT technology. For these computer applications, future CRT requirements in cathodoluminescent phosphors, vacuum bulb face plates, storage tubes, projection tubes, and deflection yokes will be defined.

SESSION 25

Tuesday 9:00–11:30 A.M.
New York Hilton, Rhinelander Gallery South

Sponsored by Computer Group

A Survey of Computer Operating Systems

Chairman: G. J. Moshos, RCA-EDP, Camden, N.J.

This session presents for computer users a state-of-the-art survey of computer operating systems. An ideal operating system is designed to provide each user with those functions that he may require without the system itself being a burden or penalizing individual users sharing a computer (for example, to provide automatic job transition, programming languages good for large and small jobs, easy-to-use and reliable control of a variety of input/output devices, flexible methods of program testing, etc.). Each invited paper will present a different organization of an operating system; that is, the batch-multiprogramming system and the on-line/real-time system, for accomplishing this design goal.

25.1 Evolution of Computer Operating Systems, *W. C. Lynch, Case Institute of Technology, Cleveland, Ohio*
This paper will trace the development of operating systems, both automatic and manual, for large, multipurpose computing systems. Such an historical review will provide the perspective for appreciating both the facilities available in current computer systems and the reasons for their existance. This leads to an extrapolation of the features of future executive systems and leads to an examination of the design rational for time-sharing systems. In this review we will examine card, tape, disk, and drum-oriented operating systems as well as multiprogramming systems. Time-sharing systems, beyond their design rationale, will not be considered.

25.2 Time Sharing Systems: A Review, *B. W. Arden, Univ. of Michigan, Ann Arbor*
The purpose of this paper is to examine briefly several existing and developmental time-sharing systems in order to determine the common direction of these efforts. The similarities and differences between special- and general-purpose systems are considered and the hardware

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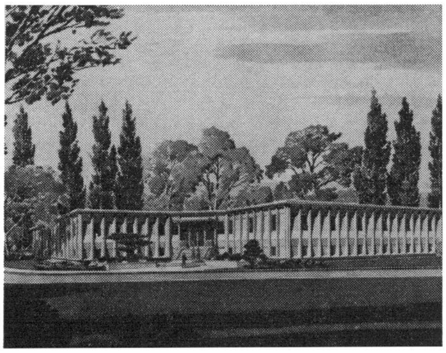

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and software organization of the general-purpose systems are analyzed. Of particular interest is the impact of real-time demands on the scheduling and program switching algorithms. The dependence of system design and performance on statistical considerations has led to some modeling and simulation activities, which are also reviewed.

SESSION 26

Tuesday 9:00–11:30 A.M.
New York Hilton, Sutton Ballroom North

Sponsored by Aerospace and Electronic Systems Group

On-Board Checkout for Aerospace Systems

Chairman: Maj. Gen. L. E. Lyle, Director, Directorate of Maintenance Engineering, Air Force Logistics Command Hq., Wright-Patterson Air Force Base, Ohio

Built-in test and on-board checkout are being applied, in one form or another, to nearly every new aerospace vehicle being designed today. This session will highlight the knowledge and experience gained to date and will explore some of the new ideas in the field. Along these lines, we have included papers covering both manned space vehicles, aircraft applications and even the role of on-board checkout for undersea craft. Although present and past applications will be covered, the session will stress the future—future needs, future techniques, and future hardware.

26.1 In-Flight Checkout—Apollo and Post-Apollo Concepts, *R. W. Lanzkron, Chief, Command & Service Module, Project Engineering & Checkout Div., Manned Spacecraft Center, NASA, Houston, Tex.*
As flights become longer, and more extended time is used in travel, or space modules are designed for specific use after long space storage, checkout on board the vehicles has to be performed. The man–machine interface has to be designed considering the aspects of in-flight checkout. The current Apollo Program represents some of the initial thinking and the application thereof. This paper discusses this thinking and uses illustrative examples of its application.

26.2 Performance Monitoring Unmanned Space Vehicles, *R. A. Neilson, Senior Engineer, Voyager Project, Jet Propulsion Lab., Pasadena, Calif.*

26.3 The Case for AIDS, "Aircraft Integrated Data Systems," *Col. R. F. Powell, Chief, Lt. Col. E. F. Vieluva, Avionics, Munitions, and Missiles Branch, Systems & Logistics Deputate, Hq. USAF, Washington D.C.*
The advanced sophistication of modern aircraft design and the need for increased utilization rates establishes a maintenance requirement for a method of in-flight systems performance evaluation and real time malfunction diagnosis. End products of systems designed for this purpose should reduce turnaround time and improve systems reliability; hopefully, the resultant efficiency will allow a saving of maintenance resources. There are problems in software development and in determining the scope of application for these systems that must be resolved before full realization of their potential can be achieved.

26.4 Combat Experience with Automatic In-Flight Fault Isolation on the E-2A Hawkeye, *H. C. Kline, Chief, Project Support Engineer, L. P. Kollender, Asst. E-2A, Support System Engineer, Grumman Aircraft Engineering Corp., Bethpage, N.Y.*
One of the least publicized, but most successful weapon systems currently in Vietnam operation is the Navy's E-2A Hawkeye airborne tactical control system. The Hawkeye's exceptional availability record is attributable, to a great degree, to its integral in-flight performance monitor, which provides a continuous check on electronics systems performance. In case of failure, the Monitor provides rapid in-flight computer-assisted fault isolation to individual aircraft replaceable assemblies.

26.5 Operational Checkout of Deep Submergence Rescue Vehicle Systems, *S. K. Sezack, Head, Deep Submergence Systems Branch, U.S. Naval Applied Science Lab., Brooklyn, N.Y.*

Panel discussion with audience participation

SESSION 27

Tuesday 9:00–11:30 A.M.
New York Hilton, Sutton Ballroom South

Sponsored by Engineering in Medicine and Biology Group

The Design of Man → Man's Design

Chairman: Manfred Clynes, Research Center, Rockland State Hospital, Orangeburg, N.Y.

The session "Design of Man → Man's Design" is meant as an opportunity to review the role of engineering in the redesign of man to fit his recognized needs. To know his present design and affect it for optimization is a meeting ground for engineering and the biomedical sciences. This session aims to present physiology as the engineering of the human organism, with emphasis on the control and communication aspects. Topics specially selected include hormonal control, perception, electrical stimulation, and system organization.

27.1 The Electrode Interface Between Man and a Prosthetic Stimulator, *Wilson Greatbatch, Dept. of Electrical Engineering, State Univ. of New York, Buffalo*
During the last decade, the "design of man" has, on occasion, been intentionally modified by the substitution of electronic prosthetics for certain lost physiological functions. Prime examples are implantable cardiac pacemakers, bladder stimulators, and carotid sinus stimulators (for long-term treatment of hypertensive patients).

This paper discusses the design of the electrode interface between natural man and his supplemental electronic prosthetics. This electrode interface is not a simple resistive connection. It has very complex electrical and chemical properties. These properties vary greatly with current density and duration as well as among various electrode materials. In particular, the paper considers the effect of electrochemical polarization on various electrode materials and how such polarization enters into overall considerations of the design of the prosthetic device.

27.2 Endocrine Control Systems, and the Control of Them, *F. E. Yates, Dept. of Physiology, Stanford Univ., Calif.*
The general organization of endocrine systems, inferred from analyses of multiple types, reveals all of them to be part of systems of hierarchical feedback loops. The description of these loops can be usefully quantified by application of even elementary control principles, and from that description, a means of intervention in fundamental biochemical processes can be found. A potential for profound

control of animal and human behavior is revealed in the analysis.

27.3 Computer Recognition of the Brain's Visual Perception Through Learning the Brain's Physiologic Language, *Manfred Clynes, M. Kohn, J. Gradijan, Research Center, Rockland State Hospital, Orangeburg, N.Y.*

27.4 Man's Intervention in Intracerebral Functions, *J. M. R. Delgado, Dept. of Physiology, Yale Univ. School of Medicine, New Haven, Conn.*

Recent technological developments permit the investigation and manipulation of intracerebral mechanisms in animals and men. By physical and chemical means, directly applied to the brain, we can start, stop, or modify a variety of autonomic, somatic, behavioral, and mental manifestations. Knowledge and control of these mechanisms represent a human intervention in the design of man.

27.5 Electromechanical Control of an Artificial Leg, *G. D. Summers, Chief, Biomedical Engineering, Republic Aviation Div., Fairchild Hiller Corp., Farmingdale, N.Y.*

Greater safety and utility for users of above-the-knee artificial legs is the goal of a newly developed electromechanical control system. Intended to be a low-cost high-utility addition to present protheses, the control system will prevent collapse of the leg, permit simulation of the natural gait, and assist in sitting, rising, and climbing.

27.6 The Organism Reorganized? *N. S. Kline, Research Center, M. Clynes, Director of Biocybernetics Lab., Rockland State Hospital, Orangeburg, N.Y.*

ORG (ERG) refers to "work or activity." Activity patterns (of *org*anisms) occur in such stable physical and psychosocial environments that we regard a species (especially the human) as relatively fixed. Historical and ethnological evidence indicates otherwise. Survival in our existentially accelerating universe requires an answer to "How and by how much can be redistribute activity of (i.e., reorganize) the human organism?"

SESSION 28

Tuesday 2:00–4:30 P.M.
New York Hilton, Gramercy Suite

Sponsored by Basic Sciences Committee

Electromagnetic Phenomena in Plasmas

Chairman: Prof. Amiya K. Sen, Columbia Univ., New York, N.Y.

The emphasis of the session is on the electrical properties of plasma. The papers will contain review material of general interest to the nonspecialist, although the speakers will also discuss recent advances in their areas. Nearly all the papers will to some extent discuss the methods of performing electrical measurements upon plasmas, and analyzing the results of such determinations. One paper will discuss the direction of research aimed at controlled thermonuclear power generation; another will discuss an interesting application of the laser to generate a dense plasma.

Material relevant to the experimental analysis of plasma fluctuations in ionospheric and terrestrial plasmas by high-frequency waves is presented in the third paper, and the final presentation deals with the interaction between the solar wind plasma and the earth's magnetic field.

28.1 Progress in Controlled Thermonuclear Research, *A. S. Bishop, U.S. Atomic Energy Commission, Washington, D.C.*

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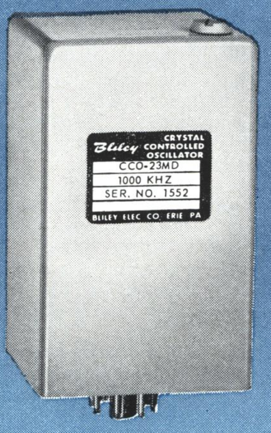

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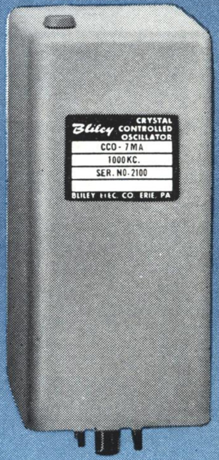

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A survey is given of recent developments in the field of controlled fusion research. The discussion centers around problems of plasma confinement, with particular emphasis on the related forms of instability: their origin, their impact on confinement, and the outlook for suppressing them.

28.2 Production of Dense Plasmas by Laser Radiation, *A. F. Haught, United Aircraft Research Labs., East Hartford, Conn.*

Using the focused radiation from high-powered *Q*-spoiled lasers, high-density, high-temperature plasmas have been produced in gases, from solid surfaces and using single micrometer-sized solid particles. The nature of the plasma obtained will be described along with studies using these plasmas for the investigation of radiation-matter interactions and plasma confinement by magnetic fields.

28.3 Scattering from Fluctuations in a Magnetoplasma, *R. F. Leheny, Y. G. Chen, T. C. Marshall, Columbia Univ., New York, N.Y.*

The scattering of microwaves from electron density fluctuations in a laboratory magnetoplasma results from a distributed, nonlinear, interaction of the transverse probing wave with longitudinal waves in the plasma. An analysis of this interaction, along with the results of a study of the electron fluctuation spectrum of a typical laboratory cylindrical plasma column, is presented.

28.4 Interaction of the Solar Wind with the Magnetoplasma, *W. I. Axford, Center for Radiophysics and Space Research, Cornell Univ., Ithaca, N.Y.*

The geomagnetic field is distorted by the solar wind into a cometlike structure called the magnetosphere. On its upstream (sunwards) side, the magnetosphere is roughly hemispherical and a standing-bow shock wave is formed allowing the supersonic solar wind to be diverted round it. Shear stresses exerted at the boundary of the magnetosphere by the solar wind cause the outermost field lines to be dragged downstream to great distances, producing a long tail in which the field lines lie more or less in the sun–earth direction. The tail collapses periodically, energizing the entrained plasma and shooting it towards the earth from the antisolar direction. The plasma thus injected is in part precipitated into the atmosphere on the night side of the earth producing aurora, while the remainder is trapped in the inner parts of the geomagnetic field forming the Van Allen radiation belts. Various aspects of this sequence of phenomena will be discussed and it will be shown that a coherent (if somewhat qualitative) account of the major effects associated with magnetic storms can be given.

SESSION 29

Tuesday 2:00–4:30 P.M.
New York Hilton, Murray Hill Suite A

Sponsored by Simulation Committee of the Automatic Control Group

System Simulation

Chairman: R. G. Abraham, Analytical Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

The "System Simulation" session, sponsored by the Automatic Control Group, contains papers on simulation by means of analog and digital computers. A variety of systems are simulated: a marine gas turbine, a large electric utility power plant, a space rendezvous, and satellites. The advantages and need for man–machine interaction in controller design are pointed out in many of the papers. One study compares the simulation of a large central station using a batch-processing digital computer and a process control computer with "hands on" capability. Another shows the advantages of using an analog computer to solve a fourth-order optimal control problem. The problem of simulating on an analog computer the specified transfer function of a linear lumped, constant-parameter system with the smallest number of integrators and with the smallest sensitivity index is discussed. Finally, the use of star-tracker sensors to achieve attitude control of satellites and the ways in which simulation is useful in gaining insight into possible problems that could result are presented.

29.1 The Digital Simulation of a Marine Gas Turbine and Its Control Using Mimic, *J. C. Fistere, Jr., Development Engineering Dept., Westinghouse Electric Corp., Lester, Pa.*

Analytical models of a compressor, turbine, and combustor are developed through the use of thermodynamic principles and empirical functions. Controller differential equations are developed from their transfer functions. These relationships are incorporated into a Mimic digital simulation language program, with appropriate input, output, and logical control functions. The results are tabulations and plots of selected system variables as the unit is subjected to specified transients.

The analytical models of the turbine components are general and may be applied to other similar units, using appropriate numerical data. The procedure for analyzing the controller may readily be applied to other transfer functions.

Certain features of the Mimic language are described, and the problem of initialization is discussed in some detail. Sample input and output are included.

29.2 Simulation of a Large Central Station, *R. G. Abraham, F. E. Wallace, Analytical Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.*

Digital computer programs for analyzing, joining, reducing, and simulating systems represented in the state-space form were used on a model of a large central station. The need for "hands on" digital simulation during controller design led to a study of the usage of a PRODAC 580 computer for this purpose. It is concluded that "hands on" digital simulation of large complex systems will become an essential tool of control engineers.

29.3 An Application of an Analog Computer to Solve the Two-Point Boundary-Value Problem for a Fourth-Order Optimal Control Problem, *V. J. Darcy, R. A. Hannen, Dept. of Electrical Engineering, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio*

The application of Pontryagin's maximum principle to trajectory optimization problems results in a two-point boundary-value problem. Computationally, this problem is solved by various digital techniques, which are sometimes inconvenient and costly. An analog computer can be used to solve a large class of two-point boundary-value problems if the accuracy is acceptable. In this paper, an analog computer is used in conjunction with a human operator who has a display of the phase planes of the admissible trajectories. The human operator, having a general knowledge of the behavior of the system, adjusts control-law parameters until the boundary conditions of the system are satisfied. Apparently this technique has been avoided previously due to the impression that unacceptable errors would be introduced in solving the problem. This technique was applied to a time-optimal rendezvous with bounds on rocket thrust and fuel available and demonstrated that accurate analog computer solutions are possible. Solutions of the rendezvous problem were compared with an exact solution using Mimic.

29.4 Simplified Processing of Star-Tracker Commands for Satellite Attitude Control, *R. D. Showman, Ames Research Center, Moffett Field, Calif.*

This paper presents a method for using gimbaled star trackers to obtain useful attitude control signals. Gimbaled trackers are required if the spacecraft is to be pointed in an arbitrary direction and if any suitable star is to be chosen as a guide star for the star tracker.

The orientation of the star trackers with respect to the vehicle (denoted by two gimbal angles) is determined by specifying guide stars for the trackers and the attitude of the spacecraft. With the trackers locked onto the guide stars, deviation of the gimbal angles from their calculated values provides a measure of the error in vehicle attitude. Since the errors are generated about axes that are not necessarily mutually orthogonal nor aligned with the spacecraft's control axes, they must be processed somehow to make them useful as control signals.

The study considered here develops an approximate method of processing the gimbal angle error signals to provide an estimate of the spacecraft's deviation from the prescribed attitude. The processor is simple enough for use aboard current spacecraft and allows satisfactory performance over as wide a range of star-tracker gimbal angles and satellite attitude as desired.

29.5 Minimum Sensitivity Designs, *J. J. Bongiorno, Jr., Electrical Engineering Dept., Polytechnic Institute of Brooklyn, N.Y.*

The use of a scalar performance index for system sensitivity in the design of feedback control systems and in the design of analog computer simulations of specified transfer functions is justified. The designs obtained are optimum in that the sensitivity index is minimized. The practicality of the designs is also demonstrated.

SESSION 30

Tuesday 2:00–4:30 P.M.
New York Hilton, Murray Hill Suite B

Sponsored by Wire Communication Committee of the Communication Technology Group

Wire Communication II— New Developments in Wire Communications

Chairman: D. M. Atkinson, General Engineer, Bell Telephone Co. of Canada, Montreal, Que., Canada

The papers in this session deal with trends in communication systems. The first deals with the technical requirement for band widening and a method of accomplishing it by coupling negative-impedance elements with the transmission medium. Legislative trends are dealt with in the second paper, which explores such areas as law enforcement, program guidance and liaison between State and Federal agencies.

The next paper is theoretical and discusses a new technique for obtaining the power sum of two independent random variables normally distributed on a dB scale.

Prominent among the latest trends in communications is the introduction of new coaxial-cable transmission systems to supplement the long-haul microwave routes.

The last paper describes the design and application of a new test set for the operation and maintenance of such systems having channel capacities up to 3600 channels.

30.1 Performance of Random Error Correcting Codes on the Switched Telephone Net-

work, *A. G. Franco, L. J. Sporta, Communications Systems Inc., Paramus, N.J.*

The performance of perfect codes on the switched telephone network is evaluated in terms of output block error probability and output bit error probability. By evaluating these codes against experimental data describing the switched telephone network it is shown that significant improvement in the block error rate is possible, but that only negligible improvement in the bit error rate is obtained even with block lengths as long as 230 bits and with redundancies approaching unity.

30.2 The Role of Telecommunications in Supporting Domestic Goals, *Col. H. R. Johnson, C. E. Lathey, USAF, Office of Telecommunications Management, Executive Office of the President, Washington, D.C.*

The major trends towards increased cooperation between federal, state, and local governments spotlight important contributions that new telecommunications technology can make in this important aspect of government activity. The paper explores this subject in such areas as law enforcement, program guidance, and liaison between state and federal agencies.

30.3 Power Addition of Independent Random Variables Normally Distributed on a dB Scale, *Matthew Derzai, American Telephone & Telegraph Co., New York, N.Y.*

A new technique is described for obtaining the power sum of two independent random variables normally distributed on a dB scale. It permits more precise computations of noise, volume, return loss, and similar distributions. Calculations show that the resultant distributions are positively skewed and, in general, more sharply peaked than normal distributions.

30.4 A New 25-MHz Transmission Measuring Set For High-Capacity Coaxial Carrier Systems, *H. H. Freytag, D. Seidel, Siemens America, Inc., New York, N.Y.*

This paper describes the design concepts and engineering aspects of a new precision test set for the operation and maintenance of high-density carrier systems with a channel capacity up to 3600 channels. High levels and frequency accuracy are combined with simplicity of operation.

SESSION 31

Tuesday 2:00–4:30 P.M.
New York Hilton, Nassau Suite

Sponsored by Engineering Management Group

Managerial Action and Organizational Effectiveness

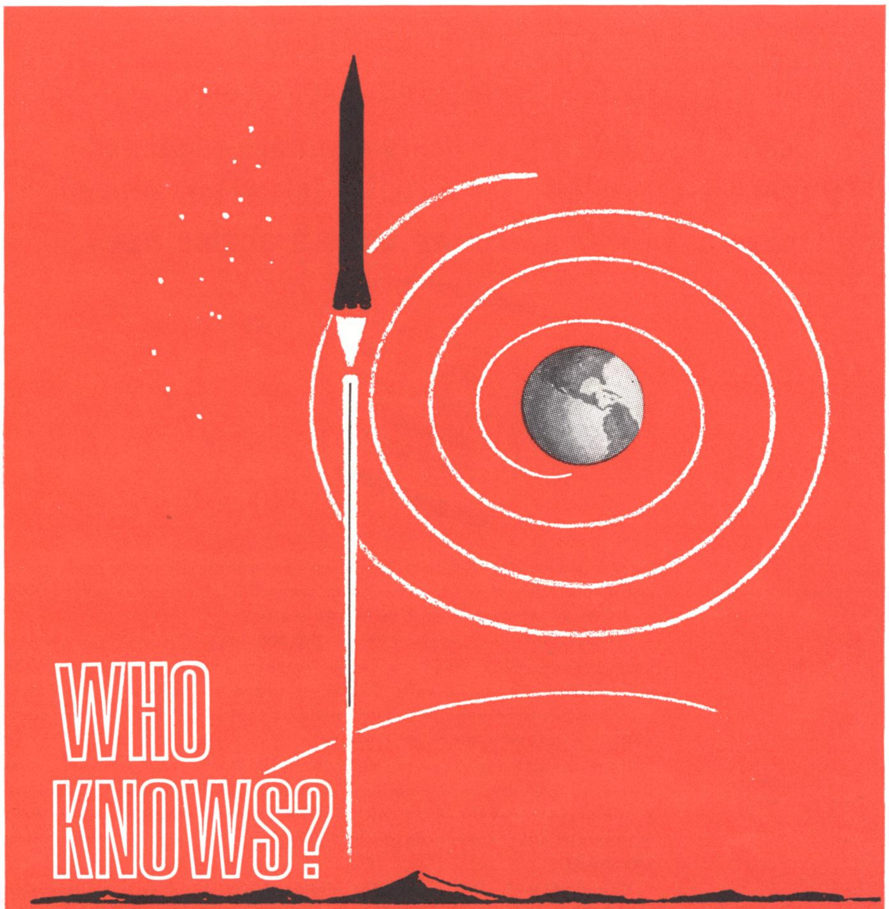
Chairman: S. J. Raiter, International Business Machines Corp., Armonk, N.Y.

Panel Discussion

The objective of this panel discussion is to provide some insight into the nature of successful engineering management. The emphasis will be necessarily on human relations because dynamic and intricate relationships between individuals are so characteristic of industrial organizations. A spectrum of techniques, some simple and some subtle, should introduce interesting aspects of supervisory practices that are sensitive to the personalities, interpersonal goals, and objectives of the diverse individuals with whom management deals.

Moderator: E. J. Tangerman, Director, Office of Planning & Development, McGraw-Hill Inc., New York, N.Y.

J. W. Haanstra, *Vice Pres. and General Manager, Federal Systems Center, International Business Machines Corp., Gaithersburg, Md.*



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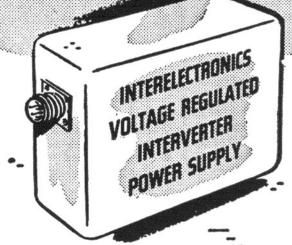

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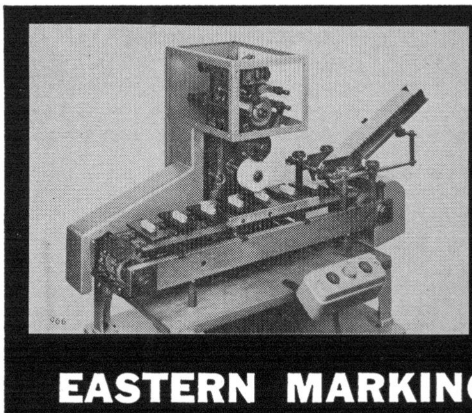

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Dr. J. R. Ragazzini, *Dean, School of Engineering and Science, New York Univ., N.Y.*
Professor R. R. Ritti, *Columbia Univ., Graduate School of Business, New York, N.Y.*
T. E. Woodruff, *Corporate Director of Systems, Sanders Associates, Nashua, N.H.*
Dr. Harold Zahl, *Research Consultant, Holmdel, N.J.*

SESSION 32

Tuesday 2:00–4:30 P.M.
New York Hilton, Regent Room

Sponsored by Marine Transportation Committee of the Industry and General Applications Group

Automation of Marine Power Systems

Chairman: W. A. Hall, General Electric Co., Schenectady, N.Y.

The session will present a coordinated series of authoritative papers based on recent developments in the marine industry. The following aspects of automation as applied to ships will be covered: (1) design and manufacture; (2) installation and test; and (3) operating experience.

Each of these subjects will be covered by papers authored by persons directly experienced in the field. The first involves companies that provide the equipment; the second involves shipbuilders; and the third, ship operators. Thus a cycle of events will be covered ranging from design to operating experience of the past several years.

32.1 Design and Manufacture of Shipboard Centralized Engine-Room Control Systems, *J. M. Shulman, W. I. Nagel, D. W. Drews, R. M. Mentz, J. A. Wasmund, R. E. Stillwagon, Westinghouse Electric Corp., Pittsburgh, Pa.*

The principal features of centralized engine-room control and the bases for selection and application of systems to particular ship conditions and the significance of materials and construction methods used in such equipment will be considered from a cost standpoint.

32.2 Shipboard Central Operation Systems—Design and Manufacture, *A. Nitsch, Industry Control Dept., General Electric Co., Salem, Va.*

The design and manufacture of central operation systems are discussed. Basic shipboard control-system concepts are reviewed, with respect to the operation of the power plant and the effects on system functions and design. Description of solid-state hardware, packaging, testing, and component reliability is included, based on experience in providing systems for 30 ships at sea and additional systems shipped or currently being manufactured.

32.3 The Shipbuilder's Role in Shipboard Automation, *W. E. Schmid, T. P. Campbell, Sun Shipbuilding & Dry Dock Co., Chester, Pa.*

The authors draw from their direct experience to discuss the installation, adjustment, and testing of shipboard automation systems. Particular lessons learned from a number of such installations are reviewed and guidance for future action is presented.

32.4 Operating Experience with Shipboard Engine-Room Automation, *N. Bachko, United States Lines, New York, N.Y.*

After a brief introduction to the background of shipboard engine room automation, the author deals directly with actual operating experience obtained on a number of U.S. Lines vessels. Specific problem areas are reviewed and possible solutions indicated within the overall perspective that engine-room automation is highly successful.

32.5 A Retrospect on Automation in Marine Engineering, *E. C. Mericas, Lykes Brothers Steamship Co., New Orleans, La.*
Emphasis is on the relatively extensive use of solid-state electronic devices used in automation systems applied to a number of vessels built for the author's company. The training of operating personnel and the operating experience with these new vessels is discussed, and the author concludes with observations as to future requirements.

SESSION 33

Tuesday 2:00–3:15 P.M.
New York Hilton, Rhinelander Gallery North

Sponsored by Electron Devices Group

A. Quantum Electronic Devices

Chairman: K. G. Hernqvist, RCA Labs., Princeton, N.J.

33.1A Advances in Gas Lasers, *P. O. Clark, Hughes Research Labs., Malibu, Calif.*
This paper will summarize the gas laser technology developed since the discovery of the He-Ne laser in 1961 and place special emphasis on the advances of the last year. The growth of the field will be considered from many aspects including available frequencies, powers and efficiencies, materials that exhibit laser action, and typical mechanisms.

33.2A An Application of Mode Locked, Laser Generated Picosecond Pulses to the Electrical Measurement Art, *H. A. Heynau, A. W. Penney, Jr., United Aircraft Research Labs., East Hartford, Conn.*
The development of mode locked Nd^{+3} glass lasers and picosecond phototransducers has made available repetitive, large amplitude picosecond pulses. The use of these pulses to determine the large-amplitude picosecond pulse characteristics of passive attenuators, delay cables, and traveling wave oscilloscopes will be discussed. The results will be compared with those obtained at small amplitudes using sampling techniques for attenuators and cables tested.

3:15–4:30 P.M.

B. Energy Conversion Devices

Chairman: P. Rappaport, RCA Labs., Princeton, N.J.

33.3B Status of Thermionic Energy Conversion, *Ned S. Rasor, Consultant, Donald W. Douglas Labs., Richland, Wash.*
Thermionic energy conversion technology is close to achieving the basic understanding, performance, and lifetime goals originally sought. Yet the comparatively high temperatures required, and the adequacy of existing power sources for present needs, still confine its application to advanced systems. Examples will be given that illustrate the potential usefulness of the technology and understanding achieved to date.

33.4B The Electric Automobile—Its Future, *Manfred Altman, Director, Institute for Direct Energy Conversion, Univ. of Pennsylvania, Philadelphia*
There has been a great deal of publicity on this subject lately. Some knowledgeable people classify the electric auto with flying saucers—fascinating, but not real—whereas others feel that the electric auto is here and that its introduction into the market is being delayed by reasons other than technical ones. This paper

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attempts to put electric vehicular propulsion in its right perspective. It reviews the possible and varied requirements, the technology available to meet certain of these requirements, and the job that remains to be done to meet others.

SESSION 34

Tuesday 2:00–4:30 P.M.
New York Hilton, Rhinelander Gallery South

Sponsored by Systems Science and Cybernetics Group

How to Apply System Analysis Properly to Biological Systems—Debate and Panel Discussion

Chairman: Dr. R. E. Machol, School of Business, Northwestern Univ., Chicago, Ill.

Biernson has asserted (*Proc. IEEE*, vol. 54, pp. 858–872, June 1966) that he has been able to throw new light on human color vision by taking a system analysis view point. MacNichol and Rushton in correspondence (*Proc. IEEE*, vol. 54, pp. 1129–1130, Aug. 1966) have attacked this article and Biernson has defended it (*Proc. IEEE*, vol. 54, pp. 1226–1229, Sept. 1966). Biernson has asserted that "the traditional physiological attitude has a serious weakness." MacNichol has called the publication of Biernson's paper "a disservice to the discipline of biomedical engineering." The protagonists will summarize their respective viewpoints, and the subject will then be discussed by the panel and by the audience.

Panel Discussion

Protagonists:

George Biernson, Senior Engineering Specialist, Sylvania Electric Products, Inc., Waltham, Mass.

E. F. MacNichol, Jr., Professor of Biophysics, The Johns Hopkins Univ., Baltimore, Md.

Panelists:

H. R. Blackwell, Professor of Physiology and Director, Institute for Research in Vision, Ohio State Univ., Columbus

Jerome Lettvin, Electrical Engineering Dept., Massachusetts Institute of Technology, Cambridge

Lawrence Stark, Professor of Information Engineering and Head of Bioengineering Group, Univ. of Illinois, and Presbyterian-St. Luke's Hospital, Chicago

SESSION 35

Tuesday 2:00–4:30 P.M.
New York Hilton, Sutton Ballroom North

Sponsored by Aerospace and Electronic Systems Group

Controlling Air Traffic in the "Super Jet" Age

Chairman: R. J. Shank, Vice President, Airborne Instruments Labs., Div. of Cutler-Hammer, Inc., Deer Park, N.Y.

Because almost all methods of flow control depend upon some degree of electrical and electronic technology whether it be sensors, communications, data processing, displays, servo mechanisms, or motor actuators, the electrical or electronic engineer is apt to have his hand in the process. The Super Jet Age will depend considerably upon us to provide it with a suitably dynamic environment.

In aviation, flow control has generally meant air traffic control. And air traffic control has had the connotation of separation control. The Grand Canyon and the Brooklyn mid-air collisions created the impression that the main purpose of traffic control was separation or collision avoidance, and indeed this is a natural consequence of flow control. But the main function of traffic control is to expedite the flow within limits established by separation standards required for safety. Thus, this session will look at air traffic control in the context of flow control in the air transportation industry.

35.1 Anglo-French ATC Preparations for the Concorde, *L. Lansalot-Basou, Director, Air Navigation, Secretariat General a l'Aviation Civile et Commerciale, Paris, France*

Anglo-French ATC preparations are made within the "Civil Servants Committee" for the CONCORDE program. Study of the problems involved has been divided in Terminal area and en route. Simulation programs are in progress both in U.K. and France. Real supersonic flights will also be inserted in existing traffic. Introduction of the EUROCONTROL simulator in early 1967 will give enhanced simulation facilities. Special attention will be given to noise problems.

35.2 The Airplane Manufacturer Looks at the Environment of the 1970s, *A. F. Norwood, The Boeing Co., Renton, Wash.*

This paper describes an environment, achievable in the 1970s and extending from departure dock to arrival dock, that will support the strong natural growth of air transportation. Those improvements in ATC and in airplane systems that are necessary to realize the full potential of advanced airplanes will be identified.

35.3 Airline Preparations for SST's and Jumbo Jets, *N. E. Halaby, Senior Vice Pres., Pan-American World Airways, Inc., New York, N.Y.*

35.4 USA–FAA Air Traffic Control Preparation for the SST's and Jumbo Jets *J. Blatt, Associate Administrator for Development, Federal Aviation Agency, Washington, D.C.*

Panel discussion with audience participation

SESSION 36

Tuesday 2:00–4:30 P.M.
New York Hilton, Sutton Ballroom South

Sponsored by Space Communication Committee of the Communication Technology Group

Space Communications

Chairman: J. G. Barry, MITRE Corp., Bedford, Mass.

This session covers several topics that are of current interest in the space communication field. The first three papers pertain to the use of a satellite as a communication relay; the fourth describes an improved deep-space range measurement system to be used with the 1967 Mariner space vehicle to Venus; and the last paper reviews experimental studies of means for overcoming the communication blackout during re-entry into the earth's atmosphere. In the communication satellite area, optimum allocation of satellites and ground facilities is discussed, a random access technique employing frequency time-hopping is analyzed, and experimental measurements of intermodulation distortion in a wideband satellite repeater are presented.

36.1 Allocation of Multiple-Access Satellites to Multiantenna Terminals, *R. J. Heppe, A. L. Cohen, System Sciences Corp., Falls Church, Va.*

Various methods are considered for maximizing the value of communications provided by a given communication satellite system configuration. A quantitative comparison is made by computer simulation of algorithms for allocating satellites and antennas to communication links under a variety of constraints, with illustrative applications.

36.2 A Frequency Time-Hopping Random Access Technique for Satellite Communications, *J. H. Wittman, Sylvania Electronic Systems, Williamsville, N.Y.*

This paper analyzes the multiple access performance of a satellite communications network, in which each user employs a hybrid frequency time-hopping random access technique for the transmittal of binary information by means of a linear, average power limited, satellite transponder. The analysis extends previous results by taking into account RF phase cancellation at the satellite as well as up- and down-link noise. The number of satellite accesses is determined as a function of data rate for various system parameters such as the redundancy, the available bandwidth, the up- and down-link capacity quotients, and the binary error rate.

36.3 Experimental Determination of Intermodulation Distortion Produced in a Wide-Band Communications Repeater, *A. L. Berman, I. E. Podraczky, Communications Satellite Corp., Washington, D.C.*

This paper describes the determination of the multicarrier performance of a wide-band satellite communications repeater. An analytic model of the final saturating graveling-wave tube is used for calculating values of useful power output and resulting carrier to intermodulation noise ratio. These are compared with measured values. The model selected is suitable for calculation of multicarrier performance of a saturating amplifier for the general case consisting of a large number of input signals randomly distributed in amplitude and frequency.

36.4 Ranging the 1967 Mariner to Venus, *R. C. Tausworthe, Jet Propulsion Lab., California Institute of Technology, Pasadena*

This paper describes a ranging system based on the same principle as the Deep Space Net standard ranging device (Mark I), but capable of extending measurements to planetary rather than lunar distances, with at least the same absolute accuracy. The increase is accomplished by digital processing of both RF Doppler and ranging information, which permit various optimizations in the transmitted code, acquisition procedure, and data handling to be made.

36.5 Techniques for Altering the Properties of Re-entry Plasmas, *M. P. Bachynski, A. I. Carswell, B. W. Gibbs, RCA Victor Research Labs., Montreal, Canada*

This paper describes laboratory studies on the use of magnetic fields to alter the plasma characteristics in order to achieve communications during re-entry "blackout." Both circularly polarized and linearly polarized waves have been used. The characteristics of various magnetoionic modes for a number of plasma conditions have been studied and the comparison of measurements with theory agree.

Measurements have also been made on the effectiveness of various electronegative gas additives for reducing the electron density in the plasma. Results are described for microwave propagation through a plasma with injections of quenching agents such as sulfur hexafluoride and water vapor.

Special Highlight Evening Symposium

Tuesday 8:00–10:30 P.M.
New York Hilton, Grand Ballroom
(See page 37)

SESSION 37

Wednesday 9:00–11:30 A.M.
New York Hilton, Gramercy Suite

Sponsored by Parts, Materials and Packaging & Electron Devices Groups

Advanced Electrical and Electronic Materials

Cochairmen: A. E. Javitz, Commonwealth Services, Inc., New York, N.Y.; James Godfrey, Bell Telephone Labs., Inc., Allentown, Pa.

This session will deal with materials for advanced electrical/electronic applications. The emphasis will be on advanced *problems*, as they may be created by operational and/or environmental conditions, rather than on advanced materials as such. Any material, whether still experimental, recent, or standard, provided it has capabilities to solve such problems, will be discussed in these papers. Associated application techniques and the effects of processing on materials properties will also be considered. Four key subjects have been selected for discussion, as indicated in the paper titles. The papers will be oriented towards the practical needs of design engineers and have been selected so as to provide for continuity between individual presentations.

Introductory Remarks: The Materials/Design Interface, *A. E. Javitz*

37.1 Materials Problems in Integrated Circuits, *J. E. Thomas, Jr., General Instrument Corp., Newark, N.J.*

The revolutionary phase in electronic development is probably nearing its end and we are entering an evolutionary phase. Even so, major changes are still to come and the results of the evolution will probably have greater economic impact than the changes that have occurred so far. The revolution has concerned itself largely with the physics of the active electronic devices, and the developers have concentrated on the interior workings of such devices with relatively little effort being applied to the problems of the interconnection, insulation, and environmental protection. The temporary solutions we have to these problems are still unsatisfactory. Encouraging progress is being made but only through a fivefold interdisciplinary attack involving the simultaneous best efforts in the fields of electronics, chemistry, physics, optics, and mechanics.

37.2 Semiconductor Materials for New Optical Devices, *L. A. D'Asaro, Bell Telephone Labs., Inc., Murray Hill, N.J.*

Semiconductor materials are currently being applied in new ways to optical devices, both in bulk devices and as junction devices. The latter provide unique interactions through the high-junction electric field and high-power density existing in a volume with dimensions comparable to the wavelength of light. Materials requirements for such devices as lasers, detectors, and modulators will be discussed.

37.3 Materials for Capacitor Dielectrics, *D. A. McLean, Bell Telephone Labs., Inc., Murray Hill, N.J.*

This paper will deal with dielectric materials and capacitors for thin-film devices and integrated circuits. Both materials and associated processing techniques will be appraised. The effect of processing on materials properties will be an important point of discussion. Evaluation of materials and processes will be within the framework of advanced functional requirements for capacitative elements. Suitable standard materials will be discussed as well as the new or experimental materials.

37.4 Materials for Conductive Elements—Part I, *Jack Spergel,* **Part II,** *W. V. Lane, both of U.S. Army Electronics Command, Ft. Monmouth, N.J.*

This paper will examine two aspects of the subject: (1) flat cable materials and techniques, and (2) thin-film conductive elements. The first part will describe and evaluate the basic cable design concepts in respect to specific application problems in advanced design. Both insulating and conductor materials will be discussed as constituents of functional cable systems. Application methods, including termination problems, will be also covered. The second part will deal primarily with the development and evaluation of bonding techniques for fine wire-to-thin film microbonds. Significant variables, including conductor composition, size and treatment, substrate material and condition, film type and thickness, and other primary variables, in various combinations, will be evaluated.

SESSION 38

Wednesday 9:00–11:30 A.M.
New York Hilton, Murray Hill Suite A

Sponsored by Education Committee

Overview—Interdisciplinary Aspects of Three Groups

Chairman: C. H. Weaver, Dean, Univ. of Tennessee, Knoxville

An Inter-Group Educational Seminar, the first of its kind to be presented at an IEEE International Convention, will take place at this session. The interdisciplinary session is an experimental one organized through the cooperative efforts of S. Levine, J. Lienesch, and E. Jahr, the chairmen, respectively, of the IEEE Groups on Computers, Industrial Electronics and Control Instrumentation, and Reliability. The purpose of the papers presented is to acquaint interested engineers in various fields with general knowledge that they might find useful in their chosen career fields. For this reason the speakers will concentrate on the major impact points of their professional fields on engineering as a whole and will shun highly specialized technical jargon.

38.1 Achievements in Industrial Electronics and Control Instrumentation, *E. A. Weiss, Coordinator Corporate Computer Planning, Sun Oil Co., Philadelphia, Pa.*

Industry's present level of application of electronics, controls, and associated instrumentation is described in terms of general principles rather than specific devices. Advertising fiction is pointedly distinguished from practical reality. Future trends are remarked on in terms of both direction and rate.

38.2 A Basic Introduction to Reliability Engineering, *H. C. Jones, Advisory Engineer, Westinghouse Aerospace Div., Baltimore, Md.*

This paper presents the basic principles of a relatively new engineering discipline—reliability engineering. Its purpose is to inform those unfamiliar with the field as to its salient points and to clearly differentiate between reliability as a product characteristic and reliability as an engineering discipline. The paper will discuss reliability predictions, reliability controls, and reliability verification in the context of an overall reliability program. It will conclude with a discussion of how the reliability engineering discipline augments and interacts with other engineering disciplines.

38.3 Computer Advances and the Engineer, *S. Levine, Bunker Ramo Corp., Stamford, Conn.*

The digital computer system is becoming an important tool in many aspects of engineering. Application areas include power engineering, computer-aided circuit design, design automation of printed circuit cards, and back plane wiring, systems simulation, and information and reference retrieval. Time-shared use of computers and man–computer graphical displays that provide for interaction between the engineer and the computer will permit more sophisticated use of the computer. These developments point up the need for continuing education in all fields of engineering.

SESSION 39

Wednesday 9:00–11:30 A.M.
New York Hilton, Murray Hill Suite B

Sponsored by Data Communication and Telegraph Systems Committee of the Communication Technology Group

Advances in Data and Telegraph Systems and Facsimile

Chairman: W. G. Vieth, Western Union Telegraph Co., New York, N.Y.

As in previous years, papers in the fields of facsimile and of printing telegraph equipment respectively, survey new techniques and recently developed equipment. The printing telegraph survey covers developments in the United States and abroad, and at notably higher speeds than heretofore. A paper planned as the first of an annual series describes new techniques and apparatus for displaying alpha-numeric information. A fourth paper describes the use of a pushbutton telephone in combination with a new data set for sending and receiving digitized information.

39.1 Advancements in the Facsimile Art During 1966, *W. H. Bliss, Astro-Electronics Div., Radio Corp. of America, Princeton, N.J.*

The main purpose of this paper is to present new features and developments in the facsimile field that do not warrant full-length papers. A further objective is to furnish an outlet and listing of the recent improvements and advancements in the art. In order to present the latest and most up-to-date information, the material is collected as late in the year as possible. Eleven companies were invited to send contributions for the 1966 paper.

39.2 Recent Developments in Display Telegraphy, *C. R. Fisher, Stromberg-Carlson Div., General Dynamics, Rochester, N.Y.*

This is the first of a planned series of papers on display telegraphy, which will annually highlight new techniques and equipment that do not constitute enough significance to warrant individual papers. This first annual paper is, however, more of a tutorial survey of what is presently on the market. It gives brief descriptions of features and technology used in each system. Where available, references for more detailed papers on each system are also given. Succeeding years' papers will then cover only advances or new information not covered in this year's paper or not covered in other papers sponsored by this institute.

Eleven known suppliers of direct-view (non-hard copy) display units for remote computer inquiry were asked for contributions to this paper. Where direct responses have not been received, information available from sales literature has been included.

39.3 Advances in Printing Telegraphy and Data in 1966, *W. Y. Lang, Consultant, Teleprinter & Data Apparatus, Towaco, N.J.*

This paper consists of contributions from developers and suppliers of printing telegraph and data equipment. Included are items from France, Germany, Japan, Switzerland, and the United States.

Items that are notable are: a high-speed electrostatic printer, which produces five copies at a speed of 200 000 words per minute; an electronic converter for use with the L0133 to permit operation at any speed from 30 to 100 bauds; units for use in Telex systems which are designed to utilize electronic rather than mechanical elements.

39.4 The Touch-Tone Telephone—Transmission of Digital Information, *J. H. Soderberg, R. R. Campbell, Bell Telephone Laboratories, Inc., Holmdel, N.J.; F. E. Bates, American Telephone and Telegraph Co., New York, N.Y.*

A discussion of the Bell System Touch-Tone® dialing system when it is alternatively used in data applications is presented. The particular aspects of this service and the hardware involved that lend themselves to alternate data uses are discussed in detail. Among the points covered are coding, the keyboard, error possibilities, and the technical aspects of the receiving data set.

SESSION 40

Wednesday 9:00–11:30 A.M.
New York Hilton, Nassau Suite

Sponsored by Industry and General Applications Group

Illumination Today and Tomorrow

Chairman: C. H. Burns, Westinghouse Electric Corp., Cleveland, Ohio

40.1 Equipment for Measuring Inrush Currents Into Magnetic Components, *G. M. Bell, Specialty Transformer Dept., General Electric Co., Fort Wayne, Ind.*

The equipment for properly synchronizing to the line, closing a modified contactor, and simultaneously measuring the applied voltage and resulting exponentially decaying current is described. Solid-state electronic circuitry is used to synchronize to the input line. A modified ac contactor, which closes in 3.5 ms, using a holding coil and trip coil and special springs, is described. A few examples are given of inrush currents taken of transformers and mercury vapor lamp ballasts. Some insight to the correlation to the I^2T capabilities of fuses is also given.

40.2 Study of Lighting Equipment in Corrosive Atmospheres, *C. B. Kenty, F. A. Stein, Holophane, New York, N.Y.*

A study of corrosion, its causes and results, is a subject to which the lighting industry has paid little attention. For this reason a study has been undertaken to include an extensive testing program of commercially available luminaires in actual field corrosion situations. The object, scope, and possible conclusions of such a test program are discussed in this paper.

40.3 What's New in Lighting? *Richard Harz, Owens Corning Fiberglas Corp., New York, N.Y.; Paul Wasdyke, Duro Test Corp., North Bergen, N.J.*

Progress has continued in 1966 with innovations throughout all phases of the lighting industry. For example, in the light source field, new high-intensity discharge lamps are changing commercial as well as industrial lighting techniques. At the same time, low-voltage incandescent systems are adding glamour and interest to residential garden lighting. New concepts of architectural lighting show a growing trend in outdoor floodlighting. In addition, outdoor area illumination is increasing the amount of leisure and recreational time, both in urban and suburban communities. Very unusual uses and special applications of light sources and/or equipment in fields other than lighting have been developed this year.

SESSION 41

Wednesday 9:00–11:30 A.M.
New York Hilton, Regent Room

Sponsored by Engineering Management Group

The Impact of EDP on Engineers and Management

Chairman: Stanley Winkler, IBM Federal Systems Div., Gaithersburg, Md.

Panel Discussion

This panel discussion will consider recent trends in computer technology—in particular, electronic data processing—in relation to influences on communications, organization planning, and decision-making functions of engineering management. The role of engineers in this changing environment will also be discussed. The panelists will present a technique for decision making that is applicable in complex situations, a description of an industrial information system and related management practices, a discussion of computer aids to enhancing the creative role of the engineer, and an exchange of views on the directions of new developments and related problems.

A Contender Evaluation and Selection Technique (CONTEST), *J. P. Craven, Manager, Deep Submergence Systems Project, Dept. of the Navy, Chevy Chase, Md.; Alfred Skolnick, SES Project Director, David Taylor Model Basin, Washington, D.C.*

A new decision-making technique, CONTEST, for evaluation of contenders where the criteria are subjective, has been formulated. It is based on psychological principles and an analogy with techniques for cross-correlation. It has been applied to a number of evaluation situations with a high degree of success. It lends itself to extension to evaluations involving large numbers of contenders in similar judgment situations.

Information Systems and Management Practice, *A. G. Beged Dov, Senior Research Engineer, Western Electric Co., Princeton, N.J.*

This paper presents the major considerations that probably motivate top management to undertake the design of a company-wide information system. The strategic advantages that may result are stated. It is argued that the best approach in designing an information system requires an evaluation of the idealized information needs of the company, and not the consolidating and computerizing of existing information gathering procedures. The probable features of future information systems are outlined.

Industrial Dynamics Techniques in Engineering Management, *J. W. Forrester, Professor of Industrial Management, Massachusetts Institute of Technology, Cambridge*

Computer Aids to Enhancing the Creative Role of the Engineer, *H. M. Sarasohn, Director of Engineering Communications, International Business Machines Corp., Armonk, N.Y.*

Engineering creativity depends upon technical knowledge, intellectual capability, and motivation; and also, most important, upon having the time and opportunity for innovation. As technologies expand and engineering development and design become even more complex and difficult, time and opportunity generally seem to be less available. Thus, the creative role of the engineer is becoming severely endangered. Wisely used in significant applications, the computer can help to reverse this trend: by taking over the routine functions of data acquisition, reduction, and processing, by pretesting proposed experiments and problem solutions, and by performing tasks that are essentially administrative, rather than technical, in nature; thus freeing the engineer to concentrate on the analytical, intellectual, and cerebrational tasks that uniquely fit the talents of the professional. Specific examples of computer applications that help to enhance the creative role of the engineer are detailed and discussed in this paper with the aim of suggesting directions for further improving the management of the engineering function.

SESSION 42

Wednesday 9:00–11:30 A.M.
New York Hilton, Rhinelander Gallery North

Sponsored by Circuit Theory Group

Computer Design of Networks I

Chairman: D. A. Calahan, Dept. of Electrical Engineering, Univ. of Michigan, Ann Arbor

The circuit design engineer has in the past several years come to appreciate the potential of computer-aided circuit design techniques. The participants in this session, who have been responsible for many of the program developments in this area, present descriptions of their recent work. Topics in the talks include (1) comparison of approaches to network analysis by computer, (2) the use of graphical display in network design. A panel discussion will follow the formal presentations.

42.1 Computer Methods of Network Analysis, *F. H. Branin, Jr., System Development Div., International Business Machines Corp., Poughkeepsie, N.Y.*

This is a tutorial paper, which highlights the influence of the computer not only on the *modus operandi* of circuit design but also on network theory itself. It reviews topological properties of linear graphs and describes a matrix-topological formulation of the network problem. In addition to the classical mesh, mode, and cut-set methods, a "mixed" method of analysis is described which is applicable to dc, ac, and transient problems and underlies the so-called state-variable approach to network analysis.

Numerical methods of solving the network problem are discussed first in connection with linear and nonlinear dc networks. A new approach to ac analysis, using the mixed method and based on a numerical solution of the matrix eigenvalue problem, is described. The application of this method to the transient analysis of linear networks is also explained. Finally, the problem of instability in numerical integration of differential equations is discussed and several means of solving the problem are outlined.

42.2 Network Analysis for Systems Applications: Present Capabilities of a Maintained Computer Program, *W. W. Happ, Electronics Research Center, National Aeronautics and Space Administration, Cambridge, Mass.*

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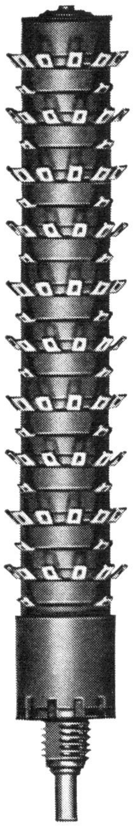

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This computer program, based on dichotomous techniques, consists of a sequence of compatible subroutines for computer-aided design, analysis, and realization of electronic circuits, devices, and systems. The program is maintained by providing (a) failure diagnostics, (b) continuous extension in scope, (c) availability for a wide variety of computer types.

42.3 A Program for On-Line Analysis of Electronic Circuits, *J. Katznelson, D. Evans, H. Lee, Dept. of Electrical Engineering, Massachusetts Institute of Technology, Cambridge*

ADENET is a system of programs designed to analyze nonlinear electrical networks on a time-shared basis. Typically, a network's input is a light pen on a cathode-ray oscilloscope, or a console typewriter; response variables are designated and calculated. The response waveforms then are displayed on the cathode-ray tube or are output on the console typewriter. If desired, the network can be modified manually or automatically after any calculation and the responses recalculated. A particularly useful feature of the system enables the user to construct an equivalent circuit for a device, assign the device a symbol, and then use the device as a basic element when constructing the network to be analyzed. AEDNET has been used to study a variety of electronic circuits; its time-shared nature enables the user to identify critical design parameters quickly.

A brief description of the system will be given, followed by a more detailed discussion of its special features.

42.4 NET-2 Circuit Analysis Program, *A. F. Malmberg, Los Alamos Scientific Lab., N. Mex.*

The general features of the NET-2 program are presented. This program, under development on the MANIAC computer, will perform nonlinear dc and transient analyses and linearized ac analyses of arbitrary circuit configurations. The program has capabilities for a variety of parameter variation and sensitivity studies.

42.5 OLCA: An On-Line Circuit Analysis System, *H. C. So, Bell Telephone Labs., Inc., Murray Hill, N.J.*

A software system for on-line analysis of linear networks is described. Inputs to the system such as circuit diagrams are given via a light pen and typewriter. Analysis results are available in various forms, including oscilloscope displays of frequency characteristics. The system guides the user through necessary steps by displayed comments; it also checks for user's errors.

Panel discussion

SESSION 43

Wednesday 9:00–11:30 A.M.
New York Hilton, Rhinelander Gallery South

Sponsored by New Technical and Scientific Committee

New Horizons in Science and Engineering I

Chairman: Detlev Bronk, Pres., Rockefeller Univ., New York, N.Y.

This symposium will involve surveys of the present state of the art and projections of the nature of the scientific and engineering areas of major importance through the 1970s by speakers who are well known in their respective fields. The sessions will provide a broad overview of basic scientific and selected engineering disciplines and generate new ideas which may spark developments in areas not yet involved in present technology. The discussions should result in a greater synthesis between the scientific and engineering communities and provide an interchange of information useful to both.

43.1 New Horizons in Physics, *R. L. Sproull, Cornell Univ., Ithaca, N.Y.*

The area of probable development within physics will be discussed, although obviously discoveries cannot be predicted. For guidance in estimating such developments, the gaps between the current positions and fundamental limits will be identified. Finally, the increasing flow of advances from physics through other sciences on their way to applications will be emphasized.

43.2 New Horizons in Quantum Electronics, *Nicolaas Bloembergen, Cruft Labs., Harvard Univ., Cambridge, Mass.*

Electronic techniques have been extended to the visible region of the spectrum since the advent of the laser. Examples of recent new devices are the ultrashort light pulse generator and the parametric tunable light oscillator. Large-scale applications of quantum electronics in communications, computers, spectroscopic analysis, and other areas are possible.

43.3 New Horizons in Chemistry, *F. H. Westheimer, Dept. of Chemistry, Harvard Univ., Cambridge, Mass.*

With the introduction of new instruments and new ideas, basic research in chemistry is in a period of rapid growth. But the application of this basic research to practical affairs is today extremely difficult. Since the most important advances, in theory and practice, will probably continue to be the unexpected ones, chemistry must be supported without overplanning it.

43.4 New Horizons in Bio-Medicine, *Britton Chance, Director, Johnson Foundation, and Chairman, Department of Biophysics and Physical Biochemistry, Univ. of Pennsylvania, Philadelphia*

SESSION 44

Wednesday 9:00–11:30 A.M.
New York Hilton, Sutton Ballroom North

Sponsored by Aerospace and Electronic Systems Group

Exploitation of the World's Oceans II

Chairman: The Hon. R. A. Frosch, Assistant Secretary of the Navy (R & D), Washington, D.C.

44.1 Electronics' Role in the Fishing Industry—Present and Future, *Dayton Alverson, Director, Exploratory Fishing and Gear Research, Bureau of Commercial Fisheries, Dept. of the Interior, Seattle, Wash.*

The electronic revolution in fisheries occurred in the years subsequent to World War II when a wide variety of electronic navigational and search devices were adapted by the commercial fishing industry. The present role of electronics in world fisheries may be categorized into four basic use functions: (1) communications, (2) navigation, (3) search, and (4) extractive processes.

Use of electric fields in the capture of fish has played only a small role, although research in progress could result in greater application of this technique in the future.

There can be no doubt that electronics will play an increasingly important role in fisheries of the future with increased emphasis on application to the search, extraction, and communication phases of fisheries.

44.2 Role of Electronics in Underwater Search, Rescue, and Recovery, *Alan Berman, Director, Hudson Labs., Columbia Univ., Dobbs Ferry, N.Y.*
In underwater search, rescue, and recovery, operations that are analogous to radio direction finding, radar search, electromagnetic navigation, and visual observation must be accomplished by largely acoustic means. Since all operations are generally carried out with remote sensors and manipulators, severe requirements are placed on the electronic instrumentation used.

44.3 Use of Navy Satellite System in Ocean Navigation and Geodesy, *R. B. Kershner, Space Development Dept. Head, Applied Physics Labs., The Johns Hopkins Univ., Silver Spring, Md.*
The Navy Navigation Satellite System has been in use by naval ships and some oceanographic research vessels for several years. Quite remarkable accuracy has been achieved with the system, particularly on land or with anchored ships. At sea, till now, the accuracy has been degraded by the difficulty of meeting the requirement to have an accurate measure of the ship's velocity in order to obtain a position fix. Recent advances have not only increased the already excellent accuracy of navigation of nonmoving points but, more important, have removed the requirement for an accurate velocity measurement as an input to the position calculation.

44.4 Economic Considerations in Application of Electronics to Deep Submergence Vehicles, *W. H. Scott, Director, Ocean Systems, Grumman Aircraft Engineering Corp., Bethpage, N.Y.*

Panel discussion with audience participation

SESSION 45

Wednesday 9:00–11:30 A.M.
New York Hilton, Sutton Ballroom South

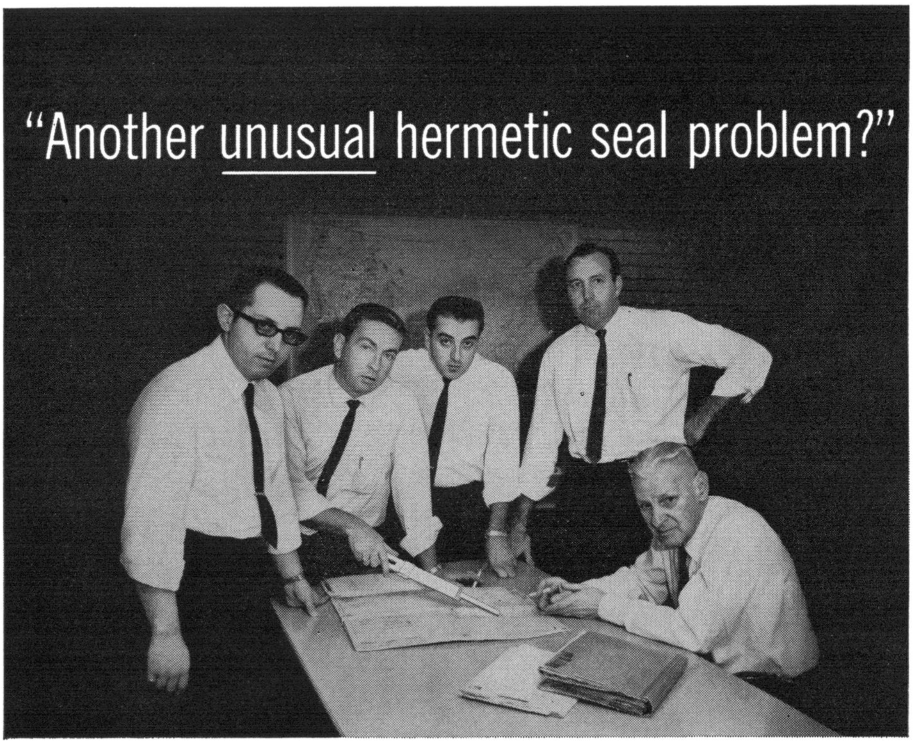
Sponsored by Information Theory Group

Signal Design and Detection

Chairman: A. J. Viterbi, Assoc. Prof. of Engineering, Dept. of Electrical Engineering, Univ. of California, Los Angeles

Beginning with a multiple-signal detection scheme that has applications in pattern recognition, the focus of this broad-ranging session then turns to two interesting uses of rank statistics in signal detection. Next, a novel method of signal design via digital coding is introduced with the use of residue arithmetic. The session ends with discussion of a digital technique for calculating signal parameters.

45.1 An Adaptive Technique for Multiple Signal Detection and Identification, *J. W. Sammon, Rome Air Development Center, Information Processing Branch, Griffiss Air Force Base, N.Y.*
A mathematical solution that can be adaptively instrumented is obtained for the multiple signal detection and identification problem when (1) the zero memory channel is corrupted by additive noise, (2) the noise statistics are approximately known (the functional form is assumed known), (3) the shapes and a priori probabilities of the signals are unknown, (4) the total number of signals is unknown, and finally (5) random samples at the receiver output constitute the only information available to the observer. Several sample problems have been simulated and experimental results are available.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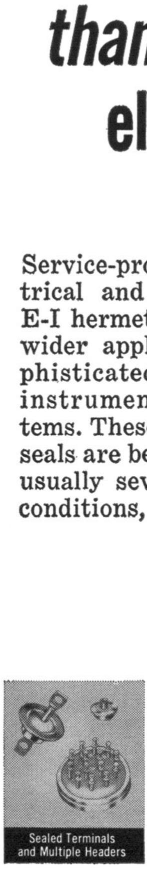
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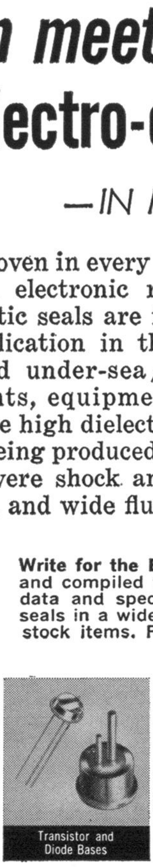
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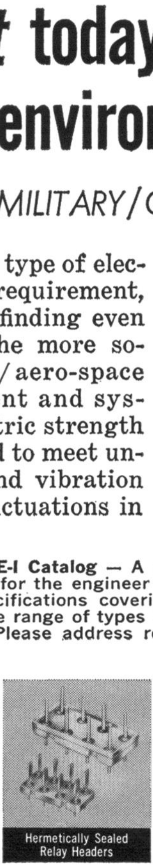
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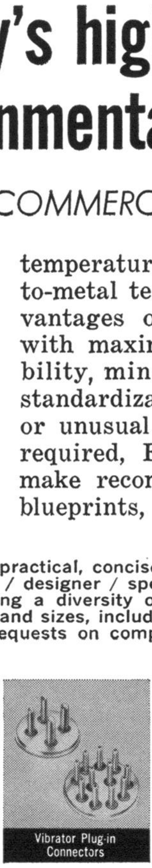
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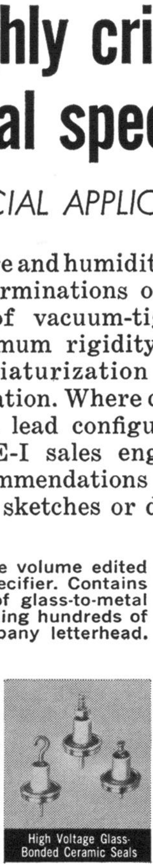
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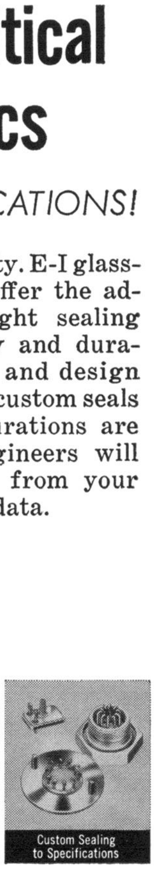
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45.2 Suboptimum Rank Detection Procedures Using Rank Vector Codes, *E. D. Stoll, Bell Telephone Labs., Inc., Holmdel, N.J.; Ludwik Kurz, Dept. of Electrical Engineering, New York Univ., Bronx, N.Y.*

A nonparametric detection scheme using only the relative ordering information of a set of samples is applied to the problem of signal discrimination. A class of codes called rank vector codes is presented and their application in this suboptimum discrimination scheme is discussed.

45.3 Nonparametric Detection by Rank Statistics—A Unified View, *E. A. Feustel, L. D. Davisson, Princeton Univ., N.J.*

This paper presents a new and unified view of nonparametric rank detection. The view taken permits a more flexible design of detectors and shows new methods for highly increased efficiency with only moderate increase in equipment complexity. It also provides a basis for understanding the relationship between optimal and suboptimal nonparametric detectors.

45.4 A Linear Residue Recurrent Code, *David Mandelbaum, Communication Systems, Inc., Paramus, N.J.*

This paper presents a recurrent (convolutional) binary code which is implemented by ordinary arithmetic methods. It makes use of a known linear residue (arithmetic) block code that corrects random errors. Unlike recurrent codes studied so far, this code does not require shift-register-type hardware for encoding and decoding operations. These operations can be accomplished by digital computers.

45.5 Digital Optimization of Exponential Representations of Signals, *R. W. Sears, Jr., Catonsville, Md.*

Representation of signals as sums of orthogonalized exponential functions can be very efficient provided that the parameters of the functions are chosen properly for the signals to be represented. Novel iterative methods using a digital computer to calculate suitable parameters have been developed. The methods can be used either on signals for which complete analytical expressions are known or, by using at each iteration the approximate representation of the signals on a "trial basis," on signals available only in continuous form. Several experimental examples, including application of the methods to an adaptive system, are presented.

SESSION 46

Wednesday 2:00–4:30 P.M.
New York Hilton, Gramercy Suite

Sponsored by Parts, Materials and Packaging Group

Integrated Circuits—Their Current Technology and Economy

Chairman: Alfred Levy, Radio Corp. of America, Van Nuys, Calif.

The session will treat the state of the art of integrated circuits in the light of their current status, as well as future developments. All aspects of integrated circuitry will be discussed from a technical and an economic point of view. The following is a résumé of subjects to be covered: economic considerations of integrated circuit applications to development projects as compared to their use in production quantities; producible monolithic analog circuits, their fabrication techniques and future trends; MOS devices and large MOS arrays; advantages, disadvantages, and applications of integrated microwave components; and large-scale integrated circuits, the various manufacturing approaches, and a per-logic function cost analysis. The session will conclude with a panel discussion and a question and answer period.

46.1 Integrated Circuits—Their Current Technical and Economical Status, *Floyd Kvamme, Fairchild Semiconductor Co., Mountain View, Calif.*

Integrated circuits represented greater than $150 million in sales to the semiconductor industry in 1967. The circuitry that makes up these 1967 shipments consists primarily of digital circuits of 4- to 12-gauge complexity packages operating in the 10–40-ns speed range. Linear components for general use, together with signal-shaping components, will eliminate the need for a designer to concern himself with dc bias design. Linear markets will continue to grow and will represent at least 15 percent of 1967 dollar shipments.

As predicted by early users, every major industry using logic in decision making is turning to the integrated circuit for low-cost, highly reliable equipment.

46.2 Monolithic Analog Circuits, *J. E. Solomon, T. M. Frederiksen, Motorola Semiconductor Product Div., Phoenix, Ariz.*

A short survey is given of the rapidly changing state of the art in analog monolithic circuitry. Examples of several circuits that incorporate new device and circuit techniques are given, including a wide-band dc amplifier and a high-power amplifier. Design techniques that lead to low-cost circuit functions are described and their impact on competing technologies is discussed.

46.3 MOS Complex Arrays—Today and Tomorrow, *W. R. McKinley, Philco Microelectronics, Santa Clara, Calif.*

MOS devices and arrays are discussed with consideration for improved processes that increase reliability and reduce cost. An approach is presented to optimize customer–vendor relationships on custom MOS arrays. This approach utilizes three characterized standard functional cells which will keep the customer in the integrated circuit design loop. It permits the participation of the customer in the chip design and will simplify specifications, reduce delivery time, and reduce cost.

46.4 Microwave Integrated Circuits, *Roger Webster, Texas Instruments Inc., Dallas*

Solid-state microwave devices and their application in microwave integrated circuits are discussed. The performance limitations and advantages are reviewed and comparisons are made of hybrid and monolithic circuits. Observations on the future possibilities of integrated circuits in phase array systems and microwave communications are presented.

46.5 Aspects of Large-Scale Integration, *Orville Baker, Signetics, Sunnyvale, Calif.*

The primary pressure for rapid development of large-scale integration is economic because extraordinarily low-cost per-logic function can thus be attained. Improved density and reliability are secondary factors.

One approach to LSI is the cellular method in which a wafer containing a large number of circuits is pretested, then custom metalized to interconnect the good circuits. Thus the desired subsystem function is implemented. In the long run, the cellular approach will prove less feasible economically than the more prosaic approach of fabricating exactly the subsystem required on a monolithic chip. Present and future monolithic LSI technology will be discussed. The major conclusion is that while monolithic LSI are already producible within today's technological and economic constraints, the principal delay in their widespread usage at the present is the time and cost required to bring together the complex engineering, testing, and marketing talents necessary to provide realistic service to users' needs.

Panel discussion

SESSION 47

Wednesday 2:00–4:30 P.M.
New York Hilton, Murray Hill Suite A

Sponsored by Automatic Control Group

Social Aspects of Automation

Chairman: R. L. Cosgriff, The Ohio State Univ., Columbus

The electrical engineer has played a dominant role in the automation of American industries but too often is not involved in evaluation of the social impact of automation. Three authors in this session have played an important role in industrial automation and discuss the social aspects of automation. A fourth paper reviews the economic indexes often used in evaluation of economic aspects of automation.

47.1 Measuring the Impact of Automation, *Joseph Duncan, Chief of Man Power and Regional Economics, Battelle Memorial Institute, Columbus, Ohio*

The impact of automation is typically measured through indexes such as value added per man-hour, employment per unit output, and other standard concepts of these standards. Some of the qualitative influences of automation that have significance for the complete evaluation of the social aspects of automation are suggested.

47.2 Impact of Automation in the Materials Processing Industries, *H. R. Chope, Executive Vice President, Industrial Nucleonics Corp., Columbus, Ohio*

This paper directs its attention to the economics of production in the processing industries with emphasis on the major "three M's" of manufacturing: (1) men, (2) machines, and (3) materials. About 60 percent of the "top 500" manufacturing companies in the United States can be classified as raw materials processors. In these operations, raw materials are by far the dominant cost factor—accounting for between 40 and 70 percent of the final output product cost. Operations in the materials processing industries are usually characterized by (1) continuous flow of material, (2) high material cost throughout, (3) high processing speeds, and (4) large volume of output product.

Automation in these industries exerts its greatest influence in lowering raw materials costs per unit of finished product. Automatic operations have been found *not* to eliminate jobs. In fact, if collateral services are considered, the number of total jobs increases when automatic systems are applied to these high-speed, continuous manufacturing processes.

47.3 Process Automation in the Petro-Chemical Industries, *T. M. Stout, President, Profimatics, Inc., Canoga Park, Calif.*

The use of on-line digital computers is the latest evolutionary step in process control technology. These digital computer systems are installed primarily to improve process operation and secondarily to reduce manpower. Users report only slight cuts in operator employment, offset by increased technical staff. Industrially, employment is more affected by trends to larger processing units and fewer control rooms than by automation.

47.4 Automation in the Telephone Industry, *Seth Washburn, Executive Director, Switching Div., Bell Telephone Labs., Inc., Columbus, Ohio*

Today's nationwide dial system can be viewed as a single large computer, on duty 24 hours a day, making few errors and aiding in the diagnosis of its own ailments. Utilization of technical knowledge has maximized the effectiveness of telephone people in increasing the scope and quality of telephone service.

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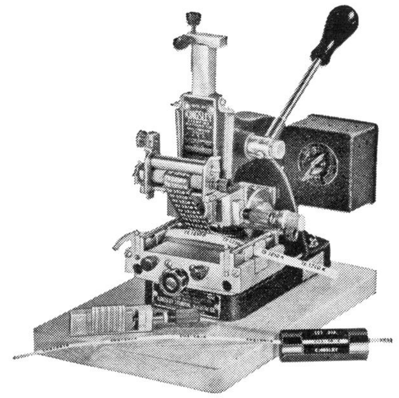

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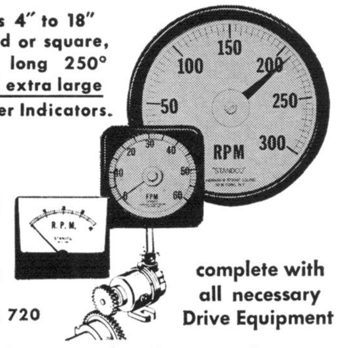

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SESSION 48

Wednesday 2:00–4:30 P.M.
New York Hilton, Murray Hill Suite B

Sponsored by Data Communication and Telegraph Systems Committee of Communication Technology Group

Methods in High-Speed Data Transmission

Chairman: P. J. Mertz, Consultant, Long Beach, N.Y.

One paper will describe the adaptation of slow-scan television techniques of satellite programs to data transmission at high information rates. Input/output elements and system trade-offs will be discussed.

Two papers discuss the increase of data signaling speeds over those possible by the duobinary method by using ternary phase difference modulation and by correlative techniques using quadrature pairs of three-level signals. Experimental results and trials on both switched and point-to-point circuits in Europe are described.

One paper describes a method for feeding a data channel from a slower, asynchronous source by adding nonsignificant pulses. Properties of the interface converters are discussed.

Another paper treats the method of avoiding buffer overflow in multichannel telemetry data compression by monitoring queue length to determine sampling rate. Several systems are compared by means of simulation.

48.1 Visual Sensors in Space, *J. J. Dishler, Astro-Electronics Div., Radio Corp. of America, Princeton, N.J.*

The special techniques developed for use on slow-scan television in orbiting satellites can be applied to ground high-data-rate transmission systems. Some of the input/output elements will be described, including visual sensors, optics, kinescope recording, and facsimile. Sample systems, such as TIROS and ESSA satellite systems, will show these elements as part of the system. Trade-off parameters of resolution, light level, electronic bandwidth, frame time, and storage time will be used to demonstrate their effects on the video transmission system.

48.2 Ternary Phase-Difference Modulation for Data Transmission in Telephone Networks, *H. H. Voss, Siemens H. G. Central Lab., Munich, Germany*

The simplest way to transmit a binary data signal is to use a binary modulation method. The limited bandwidth of a normal telephone channel sets a limit to the maximum data signaling rate attainable with binary double-sideband modulation techniques—e.g., 1200 b/s or in some cases 1800 b/s. For data transmission, it is of considerable interest to increase this signaling rate. An important way to do this is the use of multilevel modulation methods, by which the data signaling speed may be increased essentially, that is, by a factor of 2, 3, or even more. As an example, ternary phase-difference modulation is described. This method yields twice the speed attainable with binary double-sideband modulation at substantially the same bandwidth. This is achieved by a special encoding procedure and by making use of the fact that, in phase difference modulation, one of the modulation characteristics is a phase difference of zero.

48.3 Correlative Data Transmission with Coherent Recovery Using Absolute Reference, *Adam Lender, Lenkurt Electric Co., Inc., San Carlos, Calif.*

A new data transmission technique has been evolved which has twice the speed capability of the duobinary technique over an identical bandpass transmission medium. Important advantages of this technique include promising performance and a completely digital manner of signal generation thus considerably reducing circuit complexity. The system is based on the correlative method in which digital encoding forms an integral part of carrier modulation. The process is sufficiently general that it is applicable to both voice and broadband communication channels.

48.4 Synchronous–Asynchronous Data Converter, *J. Deregnaucourt, Northern Electric Co., Ltd., Research & Development Labs., Ottawa, Ont., Canada*

The interface between a data source and a data channel comprises, in general, means for synchronizing the source with the repetition rate of the channel or, conversely, synchronizing the channel with the source. When an exact synchronization is not realizable it is yet possible to interconnect a data source with a channel of slightly higher capacity by means of pulse stuffing.

This paper describes a method for connecting a data source to a data channel of higher capacity regardless of the ratio of the two pulse repetition rates provided that it stands between two arbitrary limits. The supervisory data are transmitted in series. The flexibility of the method makes it suitable for individual conversion as well as for large-capacity multiplexing.

48.5 The Prevention of Transmission Buffer Overflow in Telemetry Data Compressors, *J. E. Medlin, Lockheed Palo Alto Research Labs., Calif.*

A comparative evaluation of several feedback methods of telemetry data compressor output buffer overflow prevention is described. The study was made with the use of a computer-simulated multichannel data compressor, operating on recorded satellite telemetry data. Control methods based on tolerance variation, pre-compression filtering, and sample deletion are evaluated. The study was sponsored by the NASA/Goddard Space Flight Center.

SESSION 49

Wednesday 2:00–4:30 P.M.
New York Hilton, Nassau Suite

Sponsored by Sonics and Ultrasonics Group

Ultrasonics in Modern Signal Processing

Chairman: F. M. Smits, Bell Telephone Labs., Inc., Murray Hill, N.J.

This session aims at providing a tutorial survey of presently existing ultrasonic signal processing devices. Among these, delay lines and crystal filters perform time storage and frequency filtering functions on electrical inputs. Ultrasonic light modulation and deflectors cause light beams to be amplitude or phase modulated or to be geometrically deflected. Some characteristic applications are described: One deals with memory storage and time compression of digital pulse trains at high processing speeds, another with correlators as well as pulse compression and expansion functions utilized in radar systems combining large range and high resolution requirement.

49.1 Dispersive and Nondispersive Ultrasonic Delay Lines, *J. H. Eveleth, Anderson Labs., Inc., Bloomfield, Conn.*

The various types of ultrasonic delay lines operating between 1 MHz and 100 MHz which are in general use at present are described. The common geometrics (strip, wire, and polygon), the modes of propagation (longitudinal, torsional, and shear), and the most useful types of transducer materials (ceramic, magnetostrictive, and single crystal) are all briefly covered. Special attention is given to new developments in strip and wire lines.

49.2 Delay Line Transducer Materials, *D. A. Berlincourt, Clevite Corp., Electronic Research Div., Cleveland, Ohio*

The characteristics of piezoelectric materials used as delay-line transducers are described, with emphasis on recent developments. Electroelastic properties of several crystals with favorable mechanical characteristics ($LiGaO_2$, $LiNbO_3$, $LiTaO_3$) are reviewed. Vapor-deposited transducer materials (CdS, ZnS, and ZnO) are discussed with emphasis on effects of film orientation. Piezoelectric ceramic materials are reviewed briefly.

49.3 Ultrasonic Light Modulation and Deflection, *Robert Adler, Zenith Radio Corp., Chicago, Ill.*

Diffraction of light by ultrasound has many uses: it produces amplitude and phase modulation as well as angular deflection of light, generates sidebands at optical frequencies, provides visible readout for acoustic delay lines, and permits direct observation of acoustic radiation patterns and images. Physical understanding of the underlying process is stressed in this paper.

49.4 Monolithic Crystal Filters, *R. A. Sykes, W. L. Smith, W. J. Spencer, Bell Telephone Labs., Inc., Allentown, Pa.*

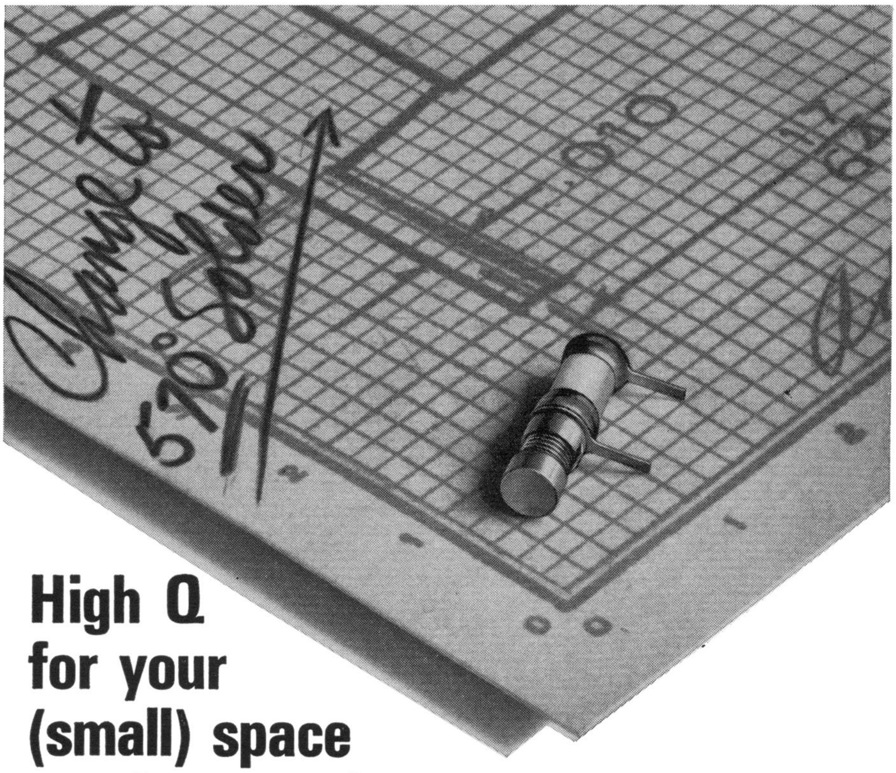
High-frequency filters with high out-of-band discrimination have traditionally been designed using quartz crystal units together with capacitors and transformers to obtain balance requirements and inductors to obtain band widening. Recent developments with multielectroded quartz plates have shown that filter functions may be realized using the mechanical coupling between the acoustic resonances trapped in the electroded regions of the quartz plate. These filters may be designed without additional components and entirely on a single quartz plate, making a completely integrated monolithic device. The bandwidth and termination impedance may be varied by changing the area and separation of the electroded regions. Filters have been fabricated in the frequency range from 5 to 40 MHz with transmission characteristics equivalent to six-pole filters. Generally these filters have less than a 0.1 percent bandwidth. By the use of overtone resonators and piezoelectric materials with higher coupling coefficients than quartz, it should be possible to make higher frequency monolithic filters with wider bandwidths.

49.5 Delay-Line Memory and Time Compression Systems, *P. S. Fuss, Bell Telephone Labs., Inc., Whippany, N.J.*

Recent ultrasonic delay line and circuit advances have made large-capacity, high-speed, low-cost digital memory and time compression systems practical. The basic principle, characteristics, and applications of these systems are presented. A state-of-the-art 28 280-word memory (48 bits per word), 40 million words per second is described.

49.6 Correlation and Pulse Compression, *L. J. Cutrona, Conductron Corp., Ann Arbor, Mich.*

In this paper the use of coherent optical techniques for the purposes of performing cross correlation and pulse compression is discussed. The role of ultrasonic light modulators in such equipments is specified. The nature of the signal operations necessary to achieve pulse compression is discussed. It is shown that the range resolution varies inversely with the bandwidth of the transmitted signal. A configuration specialized to the purposes is described.



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SESSION 50

Wednesday 2:00–4:30 P.M.
New York Hilton, Regent Room

Sponsored by Industrial Control Committee of the Industry and General Applications Group

Drive Control Applications

Chairman: J. W. Stuart, Arthur D. Little, Inc., Cambridge, Mass.

Recent years have seen an unusual degree of change in the application and control of electric power for various electrical drive equipment. Much of this change has been centered around the use of controlled rectifiers for energizing both dc motors and induction motors to achieve speed variation by the use of solid-state devices. This session covers subjects in this area ranging from the analytical to the techniques of application and provides for the presentation of papers within this range in addition to recent advances in more conventional motor protection and control.

50.1 The Performance of the Two-Phase Induction Motor with Phase-Angle Control, *J. M. Ivison, Dept. of Electrical Engineering, Loughborough College of Technology, Leicestershire, England*

The performance of the two-phase induction motor is examined under conditions when control is effected by variation of the phase of the control signal, with respect to the current in the stator reference winding. Some simplifying assumptions are made in order to obtain expressions that can be easily manipulated. The case where the currents in the stator windings are sinusoidal is of particular interest and, for this condition, the transient response of the motor to a step input (i.e., the phase of the current in the control winding is suddenly changed) is derived. The steady-state response of the motor, when a sinusoidally phase-modulated signal is applied to the control winding, is examined; this is analogous to the frequency response for an amplitude-controlled device.

The frequency response derivation is limited to low values of modulation index, and only those sidebands up to and including the third order are considered; the overall effect of these is shown to be small. Those parameters to be considered in the design of two-phase motors to be used with phase angle control are noted.

50.2 An Experimental Closed-Loop, Variable-Speed Drive Incorporating a Thyristor-Driven Induction Motor, *W. Shepherd, J. Stanway, Royal Military College of Science, Shrivenham, Swindon, Wiltshire, England*

Closed-loop control of a three-phase induction motor is investigated where the stator voltages are varied, at line frequency, by the controlled firing of silicon controlled rectifiers (thyristors). Steady-state torque–speed curves are given and the transient response of the drive to step changes of reference signal is shown. The rapid transient response of the drive due to transistorized thyristor firing circuits is demonstrated. The transfer function of the thyristor power modulator cannot be specified independently of the transfer function of the motor.

50.3 Control and Protection of DC Motor by Means of SCRs, *A. Alexandrovitz, A. Emanuel-Eigeles, Technion-Israel Institute of Technology, Haifa*

Control circuits in industry, aviation, shipping, etc., incorporate a variety of relays and contactors. The low reliability of these circuits is largely due to the moving contacts involved, which call for repeated checking and moreover are slow of response.

Recent developments in the field of semiconductors now permit replacement of electromagnetic contactors by SCRs, which are in fact contactless switches. This would result in improved reliability, simplified maintenance, and a more rapid time reponse, as well as economy in dimensions. The present paper analyzes the use of SCRs in starting, reversal, and protection of dc motors.

50.4 Test Circuit for Evaluation of Breaking Capacity of Motor Starters, *C. K. Eckels, L. H. Matthias, Allen-Bradley Co., Milwaukee, Wis.*

Series *R-L* circuits having a power factor between 40 and 50 percent with a shunting resistor drawing 1 percent of the power, are presently used for evaluating breaking capacity of motor starters. Transient recovery voltages of these circuits show anomalies that indicate that difference characteristics may be obtained from test circuits in different laboratories. It is shown that important differences in the transient recovery voltage may be caused by differences in the effective capacitance shunting the series inductance and parasitic inductance in the shunt resistor branch. The transient recovery voltages are compared with representative recovery voltages of induction motors.

50.5 Overcurrent Protection Within the Motor Branch Circuit at Low Fault Currents, *R. E. Walters, Allen-Bradley Co., Milwaukee, Wis.*

The maximum ratings of devices acceptable or the overcurrent protection of the components within the motor branch circuit are defined in the National Electrical Code. Motor starters with thermal relays usually provide this protection at the normal operating overcurrents, whereas fuses or time-delay circuit breakers provide protection at overcurrents above the permissible operating values.

The time–current characteristics of the components used for the protective function should be related in order to obtain the maximum degree of protection against overheating and the resultant damage due to excessive currents.

SESSION 51

Wednesday 2:00–4:30 P.M.
New York Hilton, Rhinelander Gallery North

Sponsored by Circuit Theory Group

Computer Design of Networks II

Chairman: Tudor Finch, Bell Telephone Labs., Inc., Murray Hill, N.J.

This is the second session devoted to a description of numerical techniques of network analysis and synthesis and man–machine oriented methods of circuit design. It is a companion session to Computer Design of Networks I.

51.1 Multilevel Approach to the Design of Networks, *J. D. Schoeffler, Systems Research Center, Case Institute of Technology, Cleveland, Ohio; A. D. Waren, Electrical Engineering Dept., Cleveland State Univ., Ohio*

An efficient approach to computer design of networks is presented based on modern systems theory. In particular, it is shown that optimal design of a network with significant structural and element value constraints can be decomposed and solved by classical approximation and realization techniques, provided that these are coordinated by optimization. As an example of this process, the design of cascade lattice filters is considered and carried through. The pertinent aspect of the optimization problem are presented.

51.2 An Efficient Method for Numerical Laplace Transform Inversion Based on Error Control, *Michael Silverberg, Dept. of Electrical Engineering, Columbia Univ., New York, N.Y.*

A computer-oriented method is presented for numerical Laplace transform inversion which will accept rapidly varying frequency data. The error in an approximation to the transform is monitored and used to locate points on the imaginary axis efficiently in order to obtain an optimum approximation which is then inverted. A numerical example is presented.

51.3 Time-Domain Synthesis Using Linear and Quadratic Programming, *J. O. Bergholm, K. A. Fegley, Moore School of Electrical Engineering, Univ. of Pennsylvania, Philadelphia*

The application of linear or quadratic programming to time-domain synthesis provides direct control over error weighting criteria; error tolerances; realizability of the resulting system function with respect to the desired type of physical elements, network configuration, and realization technique; and a trade-off between reduced errors and system complexity.

51.4 One-Port Design for Prescribed Constant Phase Angle or Imaginary Part, *S. D. Bedrosian, D. B. Luber, Moore School of Electrical Engineering, Univ. of Pennsylvania, Philadelphia*

The use of digital computers for the design of *R-L* and *R-C* one-ports is discussed for the cases of prescribed constant phase angle or constant imaginary part. Previous results of Darlington, Lerner, Orchard, and Bedrosian are unified and extended. Illustrative designs based on Chebyshev approximations over a wide bandwidth ratio are given.

51.5 A General-Purpose System of Digital Computer Codes for Linear/Nonlinear Network and System Analysis, *C. T. Kleiner, E. D. Johnson, W. D. Ashcraft, Autonetics/North American Aviation, Inc., Anaheim, Calif.*

A set of general-purpose digital computer codes for network and/or system analysis is described. Particular attention is given to the mathematical theory for the codes with simple examples of the application. Significant capability is demonstrated in the solution of complex nonlinear equations that accurately characterize the physical behavior of the bipolar transistor.

SESSION 52

Wednesday 2:00–4:30 P.M.
New York Hilton, Rhinelander Gallery South

Sponsored by New Technical and Scientific Committee

New Horizons in Science and Engineering II

Chairman: Harry Kihn, Radio Corp. of America, Princeton, N.J.

This symposium will involve surveys of the present state of the art and projections of the nature of the scientific and engineering areas of major importance through the 1970s by speakers who are well known in their respective fields. The sessions will provide a broad overview of basic scientific and selected engineering disciplines and generate new ideas which may spark developments in areas not yet involved in present technology. The discussions should result in a greater synthesis between the scientific and engineering communities and provide and interchange of information useful to both.

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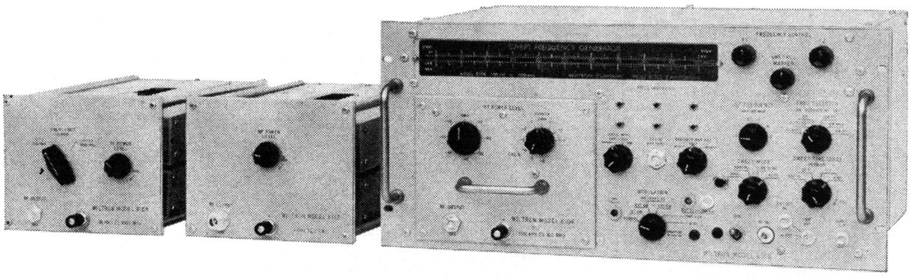

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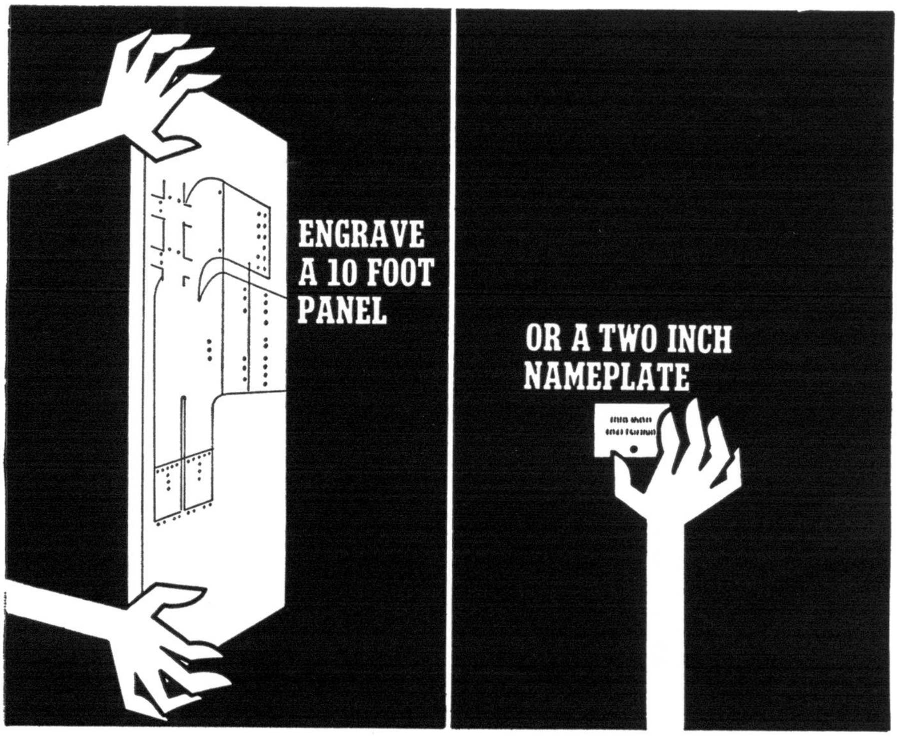

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52.1 **New Horizons in Communications,** *J. R. Pierce, Executive Director of Research, Bell Telephone Labs., Inc., Murray Hill, N.J.*

52.2 **New Horizons in Television and Broadcasting,** *G. H. Brown, Executive Vice President, Research and Engineering, Radio Corp. of America, Princeton, N.J.*

52.3 **Impact of Computers on Society,** *R. M. Fano, Massachusetts Institute of Technology, Cambridge*

52.4 **New Horizons in Microelectronic Circuits and Systems,** *S. F. Eyestone, President, North American Aviation, Inc., Anaheim, Calif.*

52.5 **Space Technology,** *A. L. Kelley, Deputy Director, NASA Electronic Research Center, Cambridge, Mass.*

SESSION 53

Wednesday 2:00–4:30 P.M.
New York Hilton, Sutton Ballroom North

Sponsored by Professional Relations Committee

Professional Relations and the Institute

Chairman: C. F. Savage, General Electric Co., New York, N.Y.

Panel Discussion

This meeting will be an open session of the Professional Relations Committee with the objective of creating an opportunity for members to inform themselves on the Institute's position and activities on subjects which are within the scope of the Professional Relations Committee.

Registration, *H. A. Moench, Rose Polytechnic Institute, Terre Haute, Ind.*

Registration as a professional engineer has not been especially attractive for the typical electrical or electronics engineer. Frequently he works as an employee of a manufacturer and so may be exempt from registration law requirements, as administered by the several states. Nevertheless, society gains some protection from incompetence if each practitioner who offers engineering services has been tested to prove that he comes up at least to a minimum acceptable level of competence in his field.

Increasingly, the "P.E." label evidences definite professional achievement. Greater uniformity of registration standards is being developed through the work of the National Council of State Boards of Engineering Examiners. A 16-hour written examination for initial P.E. registration is now required by almost all states and, as recently as Spring 1966, 8700 copies of a uniform set of questions covering the first eight hours of examination were used by more than 30 states. Registration would receive still more recognition if those presently registered were required periodically to submit evidence of continued professional activity and growth.

Ethics, *R. L. Benford, Itek Corp., Lexington, Mass.*

The engineer in industry finds few tenets of his code of ethics closely applicable to daily experiences. Transformation to the self-employed consultant domain, with clients, fees, and contracts replacing employer, salary, and tenure, can usually clarify the correlation. Additional tenets are in order, possibly derived through use of this transform.

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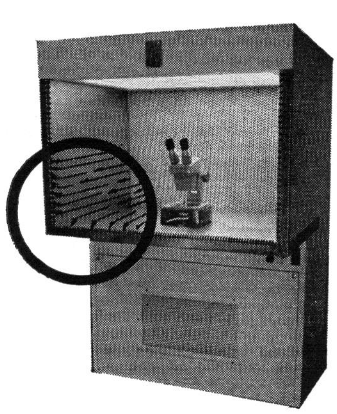

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Societies, *G. A. Kiessling, Radio Corp. of America, Camden, N.J.*

Legislative Activities Affecting Engineers, *M. F. Lunch, General Counsel, National Society of Professional Engineers, Washington, D.C.*

The legislative record of the engineering profession, while generally good, has been in a narrow range. To implement the desire that the profession be a more vital factor in legislation affecting the broad national interest it will be necessary for the profession to accept broader political, social, and economic outlooks.

SESSION 54

Wednesday 2:00–4:30 P.M.
New York Hilton, Sutton Ballroom South

Sponsored by Information Theory Group

Communication Channels—Theory Versus Practice

Chairman: R. S. Kennedy, Dept. of Electrical Engineering, Massachusetts Institute of Technology, Cambridge

This session is an effort to bridge the gap too often existent between information theoretic ideals and engineering practice. The five invited papers were chosen to illustrate the ways in which information theoretic concepts have been or could be usefully employed in actual communication systems. The channels to be considered range from the audio to the optical frequency spectra. Virtually all of the common forms of modulation and demodulation come under discussion at some point in these primarily tutorial papers.

54.1 Analog Message Transmission: Bounds and System Performance Comparisons, *H. L. Van Trees, Dept. of Electrical Engineering, Massachusetts Institute of Technology, Cambridge*

The problem of transmitting analog information over an additive Gaussian noise channel will be discussed in a tutorial manner. Performance bounds based on rate-distortion curves will be presented.

Typical transmission systems include continuous schemes such as FM and optimum angle modulation; sampled schemes such as PAM, PFM, and PAM–FM; and quantized schemes such as PCM and coded PCM. The performance of some of these typical systems will be compared with the rate-distortion bounds.

54.2 Theoretical Ideals and Their Practical Attainment for Digital Communication on Telephone Channels, *R. W. Lucky, Data Theory Dept., Bell Telephone Labs., Inc., Holmdel, N.J.*

In recent years there has been an increasing demand for more efficient means of digital communication over telephone facilities. Because of the revolutionary changes now taking place in device technology, the attainment of higher speeds and greater accuracies than are presently available seems economically assured for the near future. In this survey of the present state of the art, the characteristics of typical telephone channels are first described. Of these characteristics, the background (Gaussian) noise and the channel dispersion are controlling factors for high-speed transmission, whereas the burst noise is most important in high-accuracy considerations. The theoretical limitations imposed by these impairments are evaluated. Practical transmission systems are then described and differences between theory and practice are pointed out.

54.3 Fading Radio Channels in Telecommunications, *B. B. Barrow, Communications System Lab., Sylvania Electronic Systems, Waltham, Mass.*

This paper examines the contemporary approach to fading radio channels, particularly underspread channels such as HF and tropospheric scatter, for which the product of the multipath time-delay spread and the typical fade rate is much less than unity. The statistical characterization of short-term frequency-selective fading is discussed, and recent experimental data are presented. The use and abuse of fading channel simulators is touched upon. Finally, the impact that increased understanding of radio channels is having on the design of data transmission systems is examined.

54.4 A Study of Codes for Deep Space Telemetry, *D. R. Lumb, NASA, Ames Research Center, Moffett Field, Calif.*

Results of computer studies are described for several codes which have promise for application to the deep space telemetry channel. Two rate-1/2 trial-and-error convolutional codes of Prof. J. L. Massey and two block codes have been simulated with "a posteriori probability" (APP) for decoding of orthogonal parity checks for the Gaussian channel for different decision feedback strategies. In addition to APP decoding, sequential decoding was examined for rate-1/2 short-constraint-length convolutional codes. The codes were considered from an energy efficiency standpoint for coherent detection of PSK signals. Code performance measures, when relevant, include bit and block error probabilities, undetected word error probability for six-bit telemetry words, error propagation, computation rate, and block sizes for resynchronization.

54.5 The Atmosphere as an Optical Communication Channel, *E. V. Hoversten, Dept. of Electrical Engineering, Massachusetts Institute of Technology, Cambridge*

This largely tutorial paper is concerned with the statistical description of atmospheric effects on electromagnetic propagation at optical frequencies. The effects of both turbulence and particle scattering will be considered. However, the primary emphasis will be placed on describing a suitable statistical model for the turbulence-induced variations in various parameters of the received electromagnetic field. In particular, the spacial variations of the field over the receiving aperture will be considered. This spacial randomness provides a new dimension to the detection and estimation questions that must be considered if the atmosphere is to be efficiently used as an optical communication channel.

SESSION 55

Thursday 9:00–11:30 A.M.
New York Hilton, Gramercy Suite

Sponsored by Parts, Materials and Packaging Group

The Deep-Sea Challenge to Electronic Hardware Designers

Chairman: H. S. Samulon, Vice President and General Manager, Electronic Systems Div., TRW Systems, Redondo Beach, Calif.

With growing public awareness of the value of the seas as a natural resource, and awareness of the importance of this medium to national defense, undersea exploration is being greatly intensified. Since electronic hardware is being used extensively to reveal the nature of this inner space, the electronic hardware designer is challenged to provide equipment to meet peculiar and not-well-understood environmental conditions. The inconsistency of the environment has severely limited system ef-

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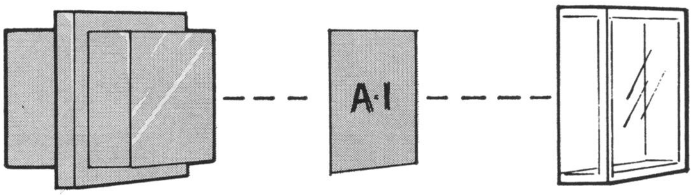

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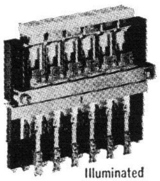

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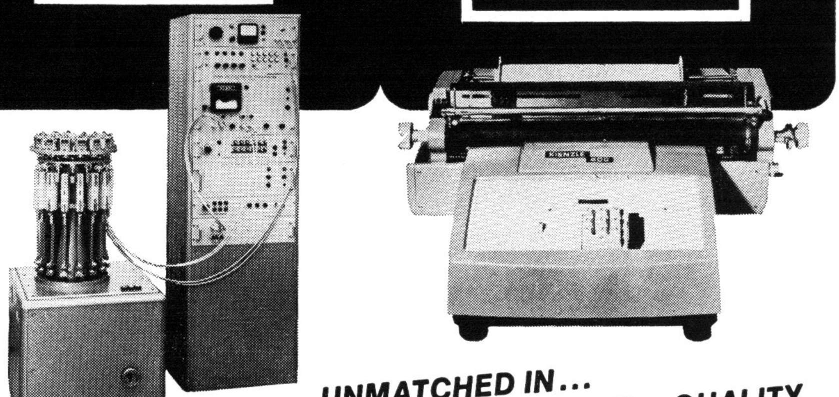

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fectiveness. Man's own responses and his ability to perform in this unnatural environment are only beginning to be evaluated. To illustrate these effects and to point up some of the challenges that must be met by the electronic hardware designer, this session brings together speakers covering quite different fields of undersea endeavor.

55.1 Sonar Engineering for Submarines and Underseas Use, *Capt. S. W. W. Shor, USN, Naval Ship Systems Command, Department of the Navy, Washington, D.C.*
Currently used sonar equipment is described to point up the urgent need for equipment design based on proved principles—not just based on good ideas. Experience of fleet use of these sonars in operational situations is the backdrop against which the need for high reliability and ease of maintenance is projected.

55.2 Research and Development Underseas Instrumentation, *George Tajima, Vice Pres., Systems Development, Marine Div., Bissett-Berman, Santa Monica, Calif.*
The expanding horizon of oceanographic research has brought out unique problems associated with instrumentation for deep submersibles. This is illustrated by descriptions of some current projects. The complexity of oceanographic data gathering by use of instrumented buoy systems is also described to illuminate further the needs in this field.

55.3 Deep Submergence Power Machinery and Controls, *J. F. McCartney, T. D. Morrison, Marine Engineering Lab., Annapolis, Md.*
Electric power provides highly versatile energy for propulsion and operation of auxiliary functions on small submersibles. A state-of-the-art description is given of electric motors, power transmission and control, and exposed cables and connectors. Problems associated with design of these devices are described, and design approaches illustrated.

55.4 Electronic Equipment for Man in the Sea, *D. M. Harrell, Medical Effects Office, Deep Submergence Systems Project Office, Department of the Navy, Chevy Chase, Md.*
The exotic environment faced by man deep in the sea brings the need for certain devices sharply into focus. Some of these needs and their value are described: reliable, easily interpreted navigation systems would free man from his tether; helium speech translators and other communication equipment improvements would increase team effectiveness; lightweight high-capacity power sources would increase his functional stamina.

SESSION 56

Thursday 9:00–11:30 A.M.
New York Hilton, Murray Hill Suite A

Sponsored by Automatic Control Group

Applications and Components

Chairman: H. R. Weed, Ohio State Univ., Columbus

This session merges the areas of application and components in an attempt to emphasize the practical side of control theory. Real problems, together with theoretical developments, are presented. The two basic areas considered are nonlinear systems and electric actuators, both servo and stepping motors. It is hoped that sessions of this character will help to combat the valid criticism of all theory and no practice emphasis.

56.1 An Application of Computer-Aided Design Methods to the Near-Optimal Control of a Damped Second-Order System, *W. L.*

Nelson, Bell Telephone Labs., Inc., Whippany, N.J.
An optimization program is developed for the optimum trade-off characteristics between the control effort and the control time for this problem. These results are then used in a design evaluation procedure which yields a simple nonlinear feedback design having good compromise performance on or near the optimum performance boundary. The performance points for some previous designs for this problem are also given.

56.2 Representation and Identification of Nonlinear Systems, *R. L. Cosgriff, H. Hemami, Ohio State Univ., Columbus*
A new functional expansion series of nonlinear systems is developed in terms of multidimensional transfer functions in frequency domain. Input and output signals are represented, respectively, by independent functions and functionals of these independent functions. The transfer functions are measurable by appropriate manipulations of the input and output signals. These derivations are based upon the representation of the signals by a nonharmonic but periodic time series.

56.3 Predicting the Nonlinear Operating Characteristics for a Two-Phase Servo Motor, *D. Springett, E. R. Corneil, Xerox Corp., Rochester, N.Y.*
The torque–speed characteristics of a two-phase servo motor varies from the desired linear characteristics. Several attempts to predict the family of torque–speed curves has been made. The empirical method of Davis and the recent development method of Kastrzhak and Sietushkin are described. Sufficient detail is given for the Kastrzhak–Sietushkin method to permit the computation of the torque–speed characteristics using easily obtained motor characteristics. To justify a relatively complex mathematical model for the motor, the effect on system employing a nonlinear two-phase servo motor is explored mathematically and experimentally.

56.4 A Direct Digital Control Stepping Motor Buffer, *K. J. Ayala, Virginia Military Institute, Lexington*
The operation of an information buffer is described. The buffer is interposed between a digital computer and up to 63 stepping motors, used in a DDC application. The buffer stores, processes, and directs information from the computer to the motors, increasing calculation efficiency.

SESSION 57

Thursday 9:00–11:30 A.M.
New York Hilton, Murray Hill Suite B

Sponsored by Communication Switching Committee of Communication Technology Group

New Services for the Telephone User

Chairman: D. L. Solomon, Office of the Secretary of Defense, Alexandria, Va.

Several new services are being made available to the residential telephone user. These services are referred to as custom calling services and include: call waiting, call transfer, speed calling, and three-way calling. Each of these features is described along with a brief history of their development and of the associated marketing trials. The central office equipment and its method of operation are discussed. Similar and additional new features are described for PBX and centrex systems. The philosophy of providing the required translation and transfer facilities in stored program and wired logic systems is discussed.

57.1 New Services for Residential Telephone Customers, *R. E. Fortenberry, American Telephone and Telegraph Co., New York, N.Y.*
A description is given of certain new custom calling services for use primarily by the residential telephone user. A brief history of their development, a description of associated marketing trials, and an estimate of their availability to the public are included.

57.2 Implementation of New Services for Residential Customers, *Wiley Whitney, Bell Telephone Labs., Inc., Columbus, Ohio; Alfred Zarouni, Bell Telephone Labs., Inc., Holmdel, N.J.*
The features and customer operating procedures of several new services are described. These services are: call waiting, call transfer, speed calling, and three-way calling. The methods of central office operation are covered, including the use of the twistor electronic memory. The administration, maintenance, and future possibilities are also discussed.

57.3 Custom Calling Services, *M. H. Bland, W. H. Stewart, Stromberg-Carlson Corp., Rochester, N.Y.*
This paper describes the four features that comprise custom calling services, which will be offered to telephone subscribers on step-by-step offices. A description is given of the various items of equipment necessary to provide these features and their mode of operation. Where the equipment will be added in the trunking scheme of a step-by-step office is also outlined.

57.4 New Services in PBX and Centrex Systems, *V. W. Witkus, American Telephone and Telegraph Co., New York, N.Y.*
This paper discusses briefly the new service features which were developed for the communication service package offerings. These service features were designed to facilitate the job of the PBX attendant and the station user and include direct station selection, camp-on, call transfer, three-way calling, trunk answer any station, and speed calling. A brief description of these features and their acceptance by the customers is included.

57.5 Implementation of New Services in PBX and Centrex Systems, *D. L. Rodkin, Bell Telephone Labs., Inc., Holmdel, N.J.*
This paper describes new services available in PBX and centrex systems and the impact that the introduction of these features has had on system designs. The philosophy of providing the required translation and transfer facilities in stored program and wired logic systems is discussed and a broad description of methods is outlined. A brief résumé of field experience to date is also given.

SESSION 58

Thursday 9:00–11:30 A.M.
New York Hilton, Nassau Suite

Sponsored by Human Factors in Electronics Group

Human Factors in High-Speed Transportation

Chairman: R. A. McFarland, Guggenheim Prof. of Aerospace Health and Safety, Harvard Univ., School of Public Health, Boston, Mass.

High-speed transportation imposes a series of requirements in basic engineering in various areas to insure the eventual development of efficient and safe systems. These technical considerations require a very high level of sophistication and are to be viewed against a

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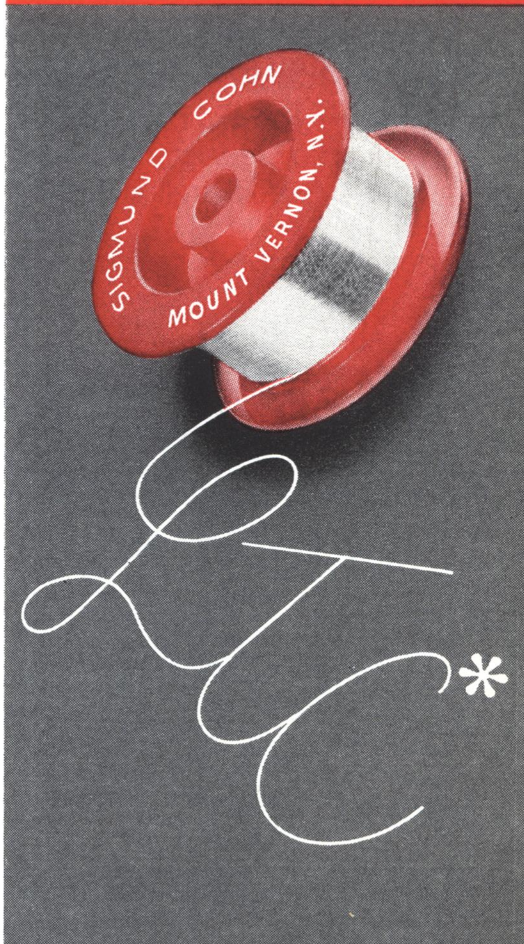

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social, economic, and political infra-structure. The values of this infra-structure are such that gradual changes will occur rather than the efficient technological innovations that are conceivable.

The papers focus on the basic requirements that relate to the human occupant controller or designer of high-speed transportation systems. Design trade-offs and safety enhancement requirements are discussed for both the immediately feasible and the more remotely possible systems.

58.1 Systems Engineering in Surface Transportation Systems, *R. M. Michaels, Science Advisor, Bureau of Public Roads, U.S. Dept. of Commerce, Washington, D.C.*

The emerging and changing needs for and uses of surface transportation are examined as are the technical requirements they have as both speeds and complexity increase. The base of science needed to meet these requirements in various areas becomes a paramount consideration as does the organization of R and D to insure development of efficient and safe systems. These technical considerations, which require a very high level of sophistication, are however cast against a social, economic, and political infra-structure. The values of this infra-structure are such that slow changes will occur rather than the efficient technological innovations that are possible.

58.2 Restraint Systems and Novel Human Packaging, *Carl Clark, Life Sciences Section, Research Dept., Martin Co., Baltimore, Md.*

58.3 Designing for Passenger Comfort in High-Speed Transportation, *R. A. McFarland, Guggenheim Prof. of Aerospace Health and Safety, Harvard Univ., School of Public Health, Boston, Mass.; H. W. Stoudt, Asst. Prof. of Physical Anthropology, Harvard School of Public Health, Cambridge, Mass.*

The concept of comfort in high-speed ground transportation is analyzed and the kinds of data needed to provide it are presented where possible. The following specific areas are discussed: effects of rates of change of acceleration and deceleration; passenger position and design of seats, standee areas, passageways, and passenger stabilizing devices. Special visual problems are considered as are miscellaneous secondary factors affecting comfort.

58.4 Human Decision Making and High-Speed Transportation, *T. B. Sheridan, Assoc. Prof. of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge*

SESSION 59

Thursday 9:00–11:30 A.M.
New York Hilton, Regent Room

Sponsored by Instrumentation and Measurement Group

What's New in Measurements?

Chairman: J. C. Riley, Portland, Oreg.

The purpose of this session is to provide for the presentation of new concepts and techniques in electrical measurement. The papers range from a proposal to use a 10-kilohm resistor as the standard for the dissemination of the unit of resistance (one paper) to a discussion of techniques for detecting and amplifying low-level dc signals (three papers) and to the description of two automated bridges, one for the measurement of resistance, the other for the measurement of impedance (two papers).

59.1 The Advantages of a Ten-Kilohm Transportable Resistance Standard, *R. M. Pailthorp, Electro Scientific Industries Inc., Portland, Oreg.*

A transportable standard resistor of a single value can be used to disseminate the legal unit of resistance from a national laboratory. Ten kilohms is a preferable value for such a resistor. This value is virtually unaffected by either lead or leakage resistance. Measurements can be made with very low power dissipation. Thermal EMF potentials are of almost no concern. Accurate calibration can be easily made relative to calculable capacitors. The resistor discussed has demonstrated high stability and exceptional immunity to its thermal and mechanical environment.

59.2 The Problems of DC Null Detection and Their Solution, *John Parnell, Frank Brem, Honeywell Inc., Denver, Colo.*

The two basic problems of dc voltage null detectors are discussed—ultimate resolution and freedom from unwanted influences—and they are related to the various sections of a chopper-type dc amplifier. The various sections of a chopper amplifier are examined and principles stated, which, if followed, help to achieve good ultimate resolution and relative freedom from unwanted influences.

59.3 FET Chopper Circuits for Low-Level Signals, *J. J. Hitt, G. Mosley, Leeds and Northrup Co., North Wales, Pa.*

The major difficulty in applying field effect transistors as low-level choppers derives from their gate-to-channel capacitance, which couples the chopper drive voltage to the signal circuit. By suitably compensating the FET and employing it as a symmetrical device in a balanced modulator circuit, such drive circuit interference can be rejected. Balanced half-wave and full-wave FET chopper circuits, capable of modulating submicrovolt signals, are described.

59.4 Measuring Currents Down to 10^{-17} Ampere with a Low Noise Level by Means of a Dynamic Capacitor Electrometer, *A. G. van Nie, Philips Research Labs.; N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands*

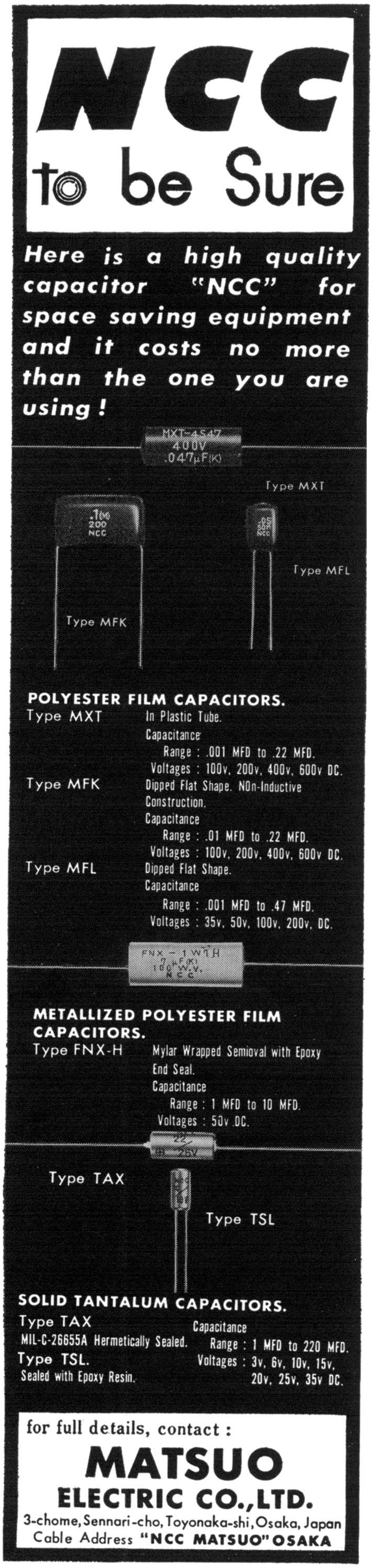
The currents to be measured are transformed by a known resistor into a voltage that is chopped by the dynamic capacitor and amplified. A special dynamic capacitor having a high conversion efficiency and a high frequency is used to minimize the influence of the amplifier noise. The time constant of the input circuit is increased by feedback. The feedback loop is arranged in such a way that the noise level remains proportional to the bandwidth.

59.5 An Accurate, Semiautomatic Technique of Measuring High Resistances, *S. H. Tsao, Div. of Applied Physics, National Research Council, Ottawa, Ont., Canada*

The paper describes an accurate (better than 0.1 percent) semiautomatic method that calibrates resistance standards between 10^9 and 10^{14} ohms at a minimum of 1 volt of 10^{-12} ampere, in typically 0.2 to 50 seconds. The value of resistance is determined in terms of a fixed three-terminal capacitance, a resistance ratio, and a standard frequency, all being stable and accurately determinable quantities. The sources of errors and their minimization are discussed: the construction and operation of such a device are described.

59.6 An Impedance Meter for Automatic Test Systems, *W. A. Plice, Honeywell Inc., Minneapolis, Minn.*

The impedance meter is a very-wide-range general-purpose instrument designed for inclusion in a computer-controlled test system. Output is in *BCD* and represents total impedance and phase angle or equivalent series *R* and *L* or *C*. Theory, line effects, shielding techniques, and final performance are discussed.



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SESSION 60

Thursday 9:00–11:30 A.M.
New York Hilton, Rhinelander Gallery North

Sponsored by Circuit Theory Group

Integrated Digital Circuits

Chairman: J. J. Suran, Electronics Lab., General Electric Co., Syracuse, N.Y.

As the level of electronic integration advances from discrete components, through circuits, to arrays, the investment required, before the first operational circuitry is available for evaluation, increases. The papers examine some of the steps necessary to minimize the iterations before a reliable, economic, and functionally useful product is achieved.

60.1 Functional Analysis of Integrated Digital Circuits, *J. J. Suran, Electronics Lab., General Electric Co., Syracuse, N.Y.*
The advent of integrated circuits, which may allow access for measurements only at the input–output terminals, has made it increasingly important to derive circuit evaluation criteria that are explicitly related to the functional requirements of the circuit as a system building block. Due to the general complexity of switching circuits, which are nonlinear by definition, computer analysis should be used if reasonable accuracy or thoroughness is to be achieved. Nevertheless, much insight into the design of digital building blocks can be obtained by relating device behavior to functional requirements by simple linear approximations. Although such approximations may be crude for predicting specific circuit responses, they serve well for comparative evaluations and for relating circuit performance to functional system requirements. Several simplified relationships, derived by linear approximations, are presented, which serve to elucidate some of the functional trade-offs that must be taken into account in switching circuit analysis or design.

60.2 Yield, Economic, and Logistic Models for Complex Digital Arrays, *R. B. Seeds, Fairchild Semiconductor Corp., Palo Alto, Calif.*
As integrated circuit designs become more complex the larger active areas consumed on the silicon die will lead to lower yields. Both analytical models and empirical data are presented that show expected yield versus die size with the conclusion that a 100-mil by 100-mil active area does not represent an unreasonable operating point. Considering chip cost factors and package cost factors, the cost per gate is examined as a function of chip complexity and 100–200-gate modules are shown to be economically advantageous. Assuming that this advantage leads to a large market in "customized" complex arrays, charts are presented to describe fundamental relationships of market variables that are used to project average cost per gate in the limit. Amortized design costs and production costs are differentiated.

60.3 Layout and Mask Generation for Large-Scale Integration, *D. L. Critchlow, International Business Machines Corp., Yorktown Heights, N.Y.*
A major problem facing the users of large-scale integrated logic circuits, where almost every logic circuit function may be unique to a given machine, is the necessity of generating a large number of layouts and masks from logic diagrams with costs and turnaround times much smaller than those satisfactory in the past for unit logic circuits. An attempt is made to put this problem in perspective, and various solutions are compared. This includes an artwork generation system developed in IBM in which the layout is designed with computer assistance, either fully automatically, starting from the logic diagram, or semiautomatically, starting from an initial sketch of the layout made by hand. The original artwork is written by a light beam and an x-y positioning table under computer control at a size (10 to 20 times final) directly compatible with a step-and-repeat camera. The "light table," which is a key part of this system, has accuracy, resolution, and travel consistent with the best available step-and-repeat camera and large-field, high-resolution lens systems. (This results in final masks with ± 15-μ inch positional repeatabilities and 0.1-mil lines over a 110-mil field.) The table can write the four 10X masks for an MOS logic array of over 100 NOR circuits in about one hour.

60.4 Discretionary Wiring: An Approach to Large-Scale Integration, *J. S. Kilby, Texas Instruments Inc., Dallas*
Each of the approaches to LSI that have been proposed have strong implications on the design of digital equipment. The inability of the designer to meet these requirements fully will be reflected in the terms of cost/design cost as well as unit cost. Time will also be important and will influence machine schedules. Several approaches to LSI are compared as to these important parameters.

60.5 Advanced Developments in Subnanosecond Integrated Logic Circuits, *J. A. Narud, Motorola Semiconductor Products Div., Phoenix, Ariz.*
Two types of integrated logic gates and several types of flip flops with a propagation delay in the range of 200 to 600 picoseconds are discussed. In addition, chip design, performance characteristics, packaging, and interconnections are explored. Also, consideration for their application to LSI is dealt with.

SESSION 61

Thursday 9:00–11:30 A.M.
New York Hilton, Rhinelander Gallery South

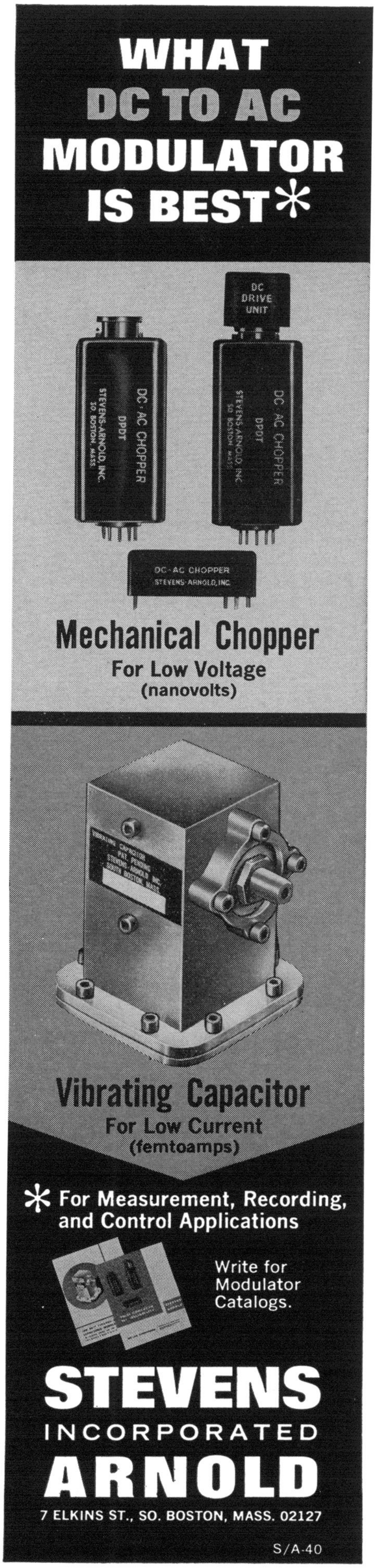
Sponsored by Infrared Technology Subcommittee of New Technical and Scientific Committee

Infrared Techniques for Nondestructive Testing

Chairman: Riccardo Vanzetti, Raytheon Co., Wayland, Mass.

The session is structured to achieve three goals: (1) to present the latest progress in the application of infrared techniques for evaluation of space-age electronics and hardware; (2) to give an idea of the wide spectrum of applications of the infrared approach, which covers the whole dimensional span from the large targets typical of the aerospace hardware to the microscopic elements of molecular electronics; and (3) to describe how the infrared approach can be useful in laboratory work and in commercial manufacturing operations as well, as demonstrated by the incorporation of an automated infrared troubleshooter in the normal production cycle of an electronics assembly plant.

61.1 Thermal and Infrared Methods for Nondestructive Testing of Adhesive Bonded Structures, *E. W. Kutzscher, K. H. Zimmermann, Lockheed-California Co., Burbank*
Thermal and infrared methods for nondestructive testing of laminated airplane structures are discussed. Results of practical meas-



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urements and coordinated mechanical strength investigations are presented.

61.2 A Novel Sensor for Microelectronic Weld Quality Evaluation, *S. N. Bobo, Jr., Program Manager, Raytheon Co., Waltham, Mass.*
One set of problems with electrically monitoring microelectronic weld quality are exchanged for another set when IR sensing replaces electrical monitoring. The use of check light sensors and conventional glass fiber optics eliminates many practical drawbacks associated with radiometry together with providing the dividend of eliminating emissivity focusing and spot-size problems.

61.3 Automated Troubleshooter Works on Infrared Signatures, *Riccardo Vanzetti, J. F. Stoddard, Raytheon Co., Wayland, Mass.*
The bridging of the last gap in the progress toward full automation of electronics manufacturing is described. The approach used is based on the discovery that every operating mode (good or faulty) of an electronic assembly is characterized by a typical, unique infrared radiation pattern, or signature. Troubleshooting can thus be reduced to an electronic pattern comparison and recognition operation that is easily carried out by conventional signal processing systems.

61.4 Infrared Radiometry of Semiconductor Devices, *David Peterman, Wilton Workman, Texas Instruments Inc., Dallas*
Infrared radiation can be used to measure the local surface temperature of semiconductor devices provided the emissivity is known. This measurement involves optical systems that collect radiant energy and focus it onto a suitable detector from which an electric signal is amplified and displayed. Depending on the optical system, detector, and display subsystems, equipment can be built having a wide variety of performance and cost trade-offs. They can be divided into basic types depending on whether they have fixed or scanning optics, long or short focal length, or real-time display. Each type is discussed and illustrated by example. Infrared radiometry can provide indirect measurement of local temperature as an important variable in design, testing, and analysis of semiconductor devices. Each of these areas is discussed and examples presented. The relation of the information gained from infrared radiometry to the understanding of device thermophysical characteristics is also illustrated.

61.5 Infrared Pinpoints Second Breakdown Before Failure, *M. F. Nowakowski, F. A. Laracuente, NASA, Marshall Space Flight Center, Huntsville, Ala.*
An investigation is being conducted to locate, measure, and analyze, through the application of direct measurement techniques, the transistor phenomenon known as "secondary breakdown." The equipment being used in this investigation is a fast-scan, high-resolution infrared microscope. The general characteristics and a brief description of the operation of the instrument are given. In addition, the results of experiments conducted using power transistors that were forced into the secondary breakdown condition in a nondestructive manner are presented.

61.6 Multiple IR Heads for Complete Control of Temperature and Growth Thickness in Epitaxial Reactors, *W. O. Hamlin, Huggins Labs. Inc., Sunnyvale, Calif.*
Single infrared sensing head temperature control being used by some semiconductor manufacturers is quite restrictive in its use and the results are questionable. Multiple heads can monitor the whole temperature profile and, thus, assist in advancement of technology and full automation of the process. Such a system and the problem involved are described.

SESSION 62

Thursday 9:00–11:30 A.M.
New York Hilton, Sutton Ballroom North

Sponsored by Metropolitan N.Y. Chapter of Engineering Management Group

The Electronics Industry—An Outlook for Engineers and Management

Chairman: H. F. Mullen, Northern Radio Co., New York, N.Y.

Panel Discussion
Moderator: A. H. Hartman, Vice President, Narragansett Capital, Providence, R.I.
The electronics industry has weathered several adjustments and is facing new problems in meeting the demands of the economy, the goals of the space program, and the technological demands of society in transportation, pollution control, and many other areas. The threats of international competition for a change in military involvement or in industrial demands may be important factors. This panel discussion considers the outlook for the industry from the perspective of the government, the financial community, and the electronics industry. Some of the themes to be considered in this panel discussion include: (1) identification, dissemination, and utilization of "new technology," (2) impact of engineering–management on the success or failure of a program or a company, (3) evaluation of technically oriented companies as investments, (4) differences in engineering–financial perspectives, (5) impact of government programs on industry prospects.

Government: *George Howick, Director, Technology Utilization Div., NASA Hq., Washington, D.C.; John Eberhard, Director, Institute of Applied Technology, National Bureau of Standards, U.S. Dept. of Commerce, Gaithersburg, Md.*

Industry: Managing Technically Oriented Electronics Companies—Next Decade, *E. D. Kenna, Vice Pres., Avco Corp., New York, N.Y.; R. L. San Soucie, Pres., Electronics and Space Div., Emerson Electric Mfg. Co., St. Louis, Mo.*
Continuation of the accelerating technological revolution in electronics is a certainty, and the management of large companies engaged in the development of major electronics systems and components will grow increasingly more difficult. As with all businesses, greater opportunities occasion greater risks, and the next ten years will require that electronics companies make major decisions that may vastly change their characters and their futures. Consider, for example, a major volume assembler of electronics components whose end product is communication equipment. Having just undergone a radical shift from vacuum-tube technology to transistorized and miniaturized circuits, he must now master the new technology of integrated circuits, and assess its impact on his particular business.

This example is only one of many that exist in the electronics industry today. This technical explosion makes possible product innovation beyond the capability of our current business management techniques. While fundamental change is being wrought quite rapidly in the techniques by which technical companies operate, this change is not keeping pace with the swift technical march of our business. Foreshortened development and testing techniques and new manufacturing processes are easier to come by than are new marketing and distribution patterns. New methods of financial control that better relate the massive research expenditures called for today to investment payout potential are required. Innovation, flexibility, and judgment have always been required of management, but for the decade that we now consider, the need will be far greater than ever before.

Financial Community: *G. A. Lodge, Director of Research, G. H. Walker & Co., New York, N.Y.; James Stegner, Senior Analyst—Electronics Group, Investors Diversified Services, Minneapolis, Minn.*

SESSION 63

Thursday 9:00–11:30 A.M.
New York Hilton, Sutton Ballroom South

Sponsored by Audio and Electroacoustics Group

Speech—Man's Natural Communication

Chairman: Leo Beranek, Bolt Beranek and Newman Co., Cambridge, Mass.

A long-term view of speech is presented, a view unlimited in either space or time. On the one hand, "speech," in its spoken and written forms, has furnished the base and means for establishing man's society with its culture, and particularly its technology. On the other hand, most of the universe runs along perfectly without any need of speech for *command and control,* the imperatives of communication. What is the explanation? What does the future hold? Outstanding authorities have been drawn from diverse speech fields to discuss these basic questions in the language of the communications design engineer.

Panel Discussion
Moderator: J. C. R. Licklider, International Business Machines Corp., Yorktown Heights, N.Y.
Origin: *G. A. Miller, Harvard Univ., Cambridge, Mass.*
Culture: *Joseph Bram, Prof. of Sociology & Television Science, Program Lecturer, New York Univ., New York, N.Y.*
Man's Mechanism: *F. S. Cooper, Haskins Labs., New York, N.Y.*
Linguistics: *John Lotz, Columbia Univ., New York, N.Y.*
Technology; *M. R. Schroeder, Bell Telephone Labs., Inc., Murray Hill, N.J.*

SESSION 64

Thursday 2:00–4:30 P.M.
New York Hilton, Gramercy Suite

Sponsored by Parts, Materials and Packaging & Electrical Insulation Groups

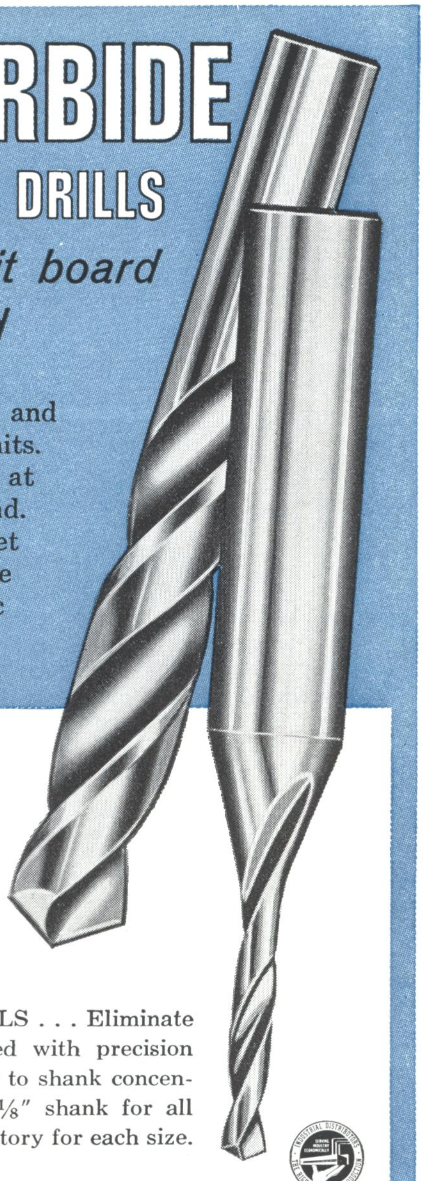
Electrical Corona

Chairman: K. N. Mathes, General Electric Co., Schenectady, N.Y.

Panel Discussion
This panel discussion by experts in the field of electrical corona will cover the various facets of the subject from theory, the effects on materials, equipments, circuits, space environments, and the state of the art as concerns detection and industry requirements with emphasis on reliability considerations. The general subject has many areas wherein there is controversy, and aside from presenting state-of-the-art reports the program will establish areas where there is complete agreement.

E. R. Bunker, Jr., Jet Propulsion Lab., Pasadena, Calif.

Corona Measurements of Apparatus as a Quality Control Test, *T. Dakin, Westinghouse Electric Corp., Research Lab., Pittsburgh, Pa.*



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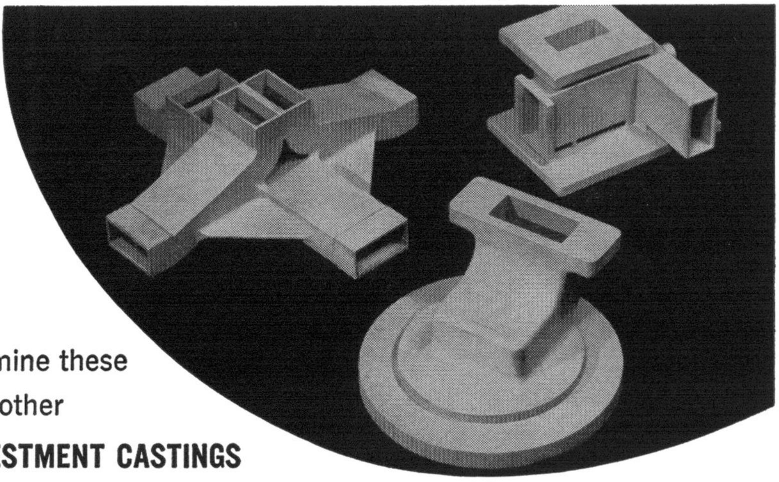

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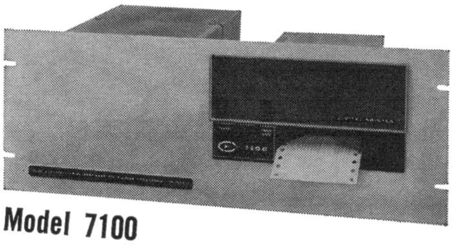

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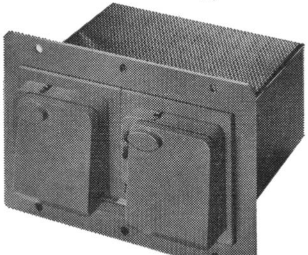

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The value and significance of corona tests to determine the quality of the insulation system of an apparatus are dealt with. The question of when the presence of corona in an apparatus should or should not be considered are discussed. It is pointed out that a single corona test must often be supplemented by other information about the materials and design of the system, or by further corona tests, to answer this question satisfactorily.

L. J. Frisco, Raychem Corp., Redwood City, Calif.

L. W. Kirkwood, Bell Telephone Labs., Inc. Whippany, N.J.
The proposed revision to ASTM-D-1868 contains a standard method for calibrating corona tests sets such that all tests sets can be calibrated to the same sensitivity. The discussion establishes corona testing as a nondestructive electric strength test and proposes that the present electric strength testing standard be replaced by the following: (1) Unless otherwise specified, corona sets should be calibrated to a sensitivity of one picocoulomb. (2) All insulation systems operating at 175 volts or below should be given an electric strength test of 500 volts rms. (3) All insulation systems operating at potentials above 175 volts peak should be given an electric strength test of 1500 volts rms. (4) Insulation systems operating at 700 volts (or above) should be corona-free at 130 percent of the maximum operating voltage.

Corona in Electronic Equipment and Circuits, *Reuben Lee, Baltimore, Md.*
In electronic equipment, corona has two major harmful effects: (1) noise in transmitted or received signals, and (2) deterioration of organic insulation. Improved detection and elimination of corona are therefore important in efficient reliable operation of equipment in which signal/noise ratio is usually of primary significance.

J. R. Perkins, E. I. du Pont de Nemours & Co., Wilmington, Dela.

SESSION 65

Thursday 2:00–4:30 P.M.
New York Hilton, Murray Hill Suite A

Sponsored by Instrumentation and Measurement & Geoscience Electronics Groups

Instrumentation for Underwater Research

Chairman: Gilbert Jaffe, Director, Oceanographic Instrumentation, U.S. Naval Oceanographic Office, Washington, D.C.

One of the key ingredients for successful underwater research is instrumentation. There are a great many variables that must be precisely measured and critically analyzed in order to better understand and effectively exploit the ocean. The papers in this session describe some of the new approaches to making oceanographic measurements. The authors have a broad range of experience in various technical areas related to oceanography. The session is designed to provide information on specific new developments as well as to exchange views between the authors and the session attendees.

65.1 Sea-State Observation with a Continuous Underwater Acoustic Signal, *R. F. Hill, Director; L. O. Jacotin, Institute of Ocean Technology, Univ. of Rhode Island, Kingston*
A study of underwater acoustic backscattering from the ocean surface suggests a scheme for measuring sea-state. Experiments in a model

tank demonstrate that the distortion of the backscattered signal is directly proportional to the rms wave height. An explanation of the results and a discussion of the ramifications are presented.

65.2 A Digital Hyperbolic Chirp Generator for Oceanographic Applications, *M. Epstein, B. Harris, Hudson Labs., Columbia Univ., Dobbs Ferry, N.Y.*
Digital hyperbolic chirp generators have considerable potential as signal sources in oceanographic research because the long-duration, wide-bandwidth, highly reproducible signals are Doppler-invariant and acceleration-tolerant. The waveform generated is accurate, the cross-correlation coefficient with ideal being better than 0.9 for signals tens of seconds long.

65.3 Ocean Surface Definition Utilizing Laser Techniques, *R. L. Kirk, Chief Scientist, Optical Systems, Electro-Optical Systems, Inc., Pasadena, Calif.*
The practical application of laser instrumentation to measure sea-surface parameters from a possible airborne platform was evaluated. The ocean surface parameters of interest were amplitude, length, and direction of waves, and the direction and velocity of surface winds. The feasibility study utilized the wind-wave channel in a pressurized room that afforded direct electrooptical evaluations of the air-water interface.

65.4 An In Situ Temperature-Salinity-Depth Recorder for Oceanographic Applications, *T. M. Dauphinee, National Research Council, Ottawa, Ont., Canada*
The apparatus gives continuous on deck records (in *XY* form) of temperature versus depth and electrical conductivity (compensated for temperature) of seawater as the measuring head is lowered or raised at 2–4 m/s. The sensing elements are a copper resistance thermometer, and a pressure diaphragm-strain gauge bridge, both supplied with direct current, and a four-electrode conductivity cell supplied with square-wave alternating current, but demodulated to give an isolated dc output.

65.5 Digital Oceanographic Data Collection System for Off-Shore Towers, *Lawrence Murdock, Manager, Ocean Sensor Systems, Amecon Div., Litton Industries, Silver Spring, Md.*
The described system includes four oceanographic sensor modules that precisely define, in digital format, conductivity, temperature, pressure, water speed, and water direction, and telemeters them through an inductive link to an on-deck unit that provides automatic programming on magnetic-tape data storage. Inductive coupling of sensor power eliminates use of batteries. A portable subassembly for checkup and attended operation completes the system.

SESSION 66

Thursday 2:00–4:30 P.M.
New York Hilton, Murray Hill Suite B

Sponsored by Communication Switching Committee of Communication Technology Group

Reliability Field Experience in Electronic Switching Systems

Chairman: S. B. Weiner, Stromberg-Carlson Corp., Rochester, N.Y.

The reliability experienced in field installations of electronic switching equipment is discussed by representatives of four different companies—one English, one German, and two American. The discussions show the relationship between system dependability and factors such as component failures, maintainability parameters, equipment self-checking features, and maintenance practices. Reliability and maintenance data from several operating systems are used to demonstrate the system dependability now being achieved and to compare these achievements with the desired objective. Customer reaction to electronic switching systems is also summarized.

66.1 Field Experience with Quasi-Electronic Telephone Switching Systems, *H. Willrett, Standard Elektrik Lorenz AG, Stuttgart, Germany*
The combination of electronic components and dry-reed contacts for use in switching systems has proved its high reliability. For several years, various types of equipment, e.g., routing translators, switching arrangements for direct distance dialing plant and local telephone offices, have been in continuous operation in the public network. Component reliability figures, gained from these devices, will be given.

66.2 Reliability and Field Experience of Electronic Switching Systems, *W. P. Karas, Stromberg-Carlson Corp., Rochester, N.Y.*
Field experience with electronic switching systems is compared with design objectives as expressed in reliability and maintainability parameters, applied from the start of design, with the purpose of meeting stringent customer requirements. A feedback system of field performance was established, reliability analysis performed, and applied to a reliability model, to determine that the established objectives were met.

66.3 Early No. 1 ESS Field Experiences, Part I—Two-Wire System for Commercial Applications, *G. Haugk, Bell Telephone Labs., Inc., Holmdel, N.J.*

66.4 Early No. 1 ESS Field Experiences, Part II—Four-Wire System for Government and Military Applications, *H. N. Seckler, Bell Telephone Labs., Inc., Naperville, Ill.*
This two-part paper describes the early field experiences the Bell System has had with its No. 1 Electronic Switching System, several of which are now in service. Included are data on customer reaction, component failure rates, and other performance criteria.

66.5 Electronic Reliability in the Field, *John Lawrence, T. F. A. Urben, British Post Office, London, England*
A review of performance and maintenance experience with electronic switching equipment now in service is given. Actual results, problems encountered, maintenance requirements, service standards, and other factors affecting the overall system dependability are described. A comparison is made with electromechanical equipment. The relationship between system design and the reliability experienced in the field is discussed.

SESSION 67

Thursday 2:00–4:30 P.M.
New York Hilton, Nassau Suite

Sponsored by Human Factors in Electronics & Systems Science and Cybernetics Groups

Man in Complex Systems

Chairman: E. S. Krendel, Univ. of Pennsylvania, Philadelphia

Four papers are presented that emphasize human decision making in complex systems. The first treats in detail the decisions required to optimize control in a one-man, one-machine system. The second deals with the information

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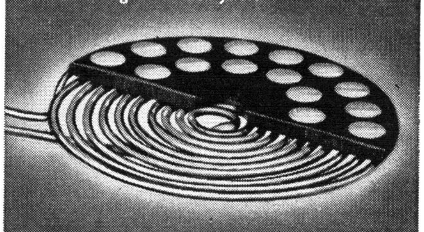
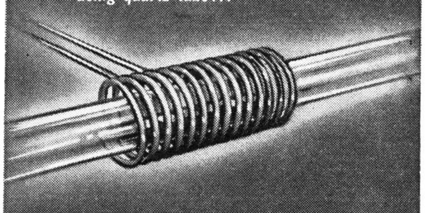


another arrangement using quartz tube...



Many solid state devices used in the Electronic, Computer and Aerospace industries depend upon material produced by Epitaxial Growth. Several methods have been developed for decomposition of the carrier gas to form an epitaxial layer on the substrate. Induction heating has been found most effective, particularly when high temperatures are required.

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UNDERWATER MISSILE SYSTEMS ENGINEERS—Analysis of acoustic homing system effectiveness and vulnerabilities. Torpedo trajectory studies and weapon system deployment. Contribute to planning computer simulation studies of acoustic homing torpedo performance and analysis of results. Working knowledge of underwater sound propagation theory is required. Related experience includes signal processing, transducer theory, digital logic, simulation, solid state techniques, and electronic circuit theory. Acoustic test and computer facilities available.

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ELECTRONIC CIRCUIT ENGINEERS—Develop design, package and evaluate digital and analog circuits to meet requirements of Weapon Control and guidance systems. Analyze, design and evaluate circuits and packaging techniques—using both discrete solid-state components and integrated microelectronic circuits for applications such as submarine based missile fire control, gun mount and antenna drives, digital servos, sophisticated space power conversion and control equipments.

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requirements for decision in a complex system of interacting men. The third paper describes how to analyze the behavior of a complex system of both men and machine. The final paper presents both the rationale for designing a sea traffic control system as well as a real-time demonstration of this system.

67.1 Evolution of Heuristics by Human Operators in Control Systems, *R. E. Thomas, J. T. Tou, Information Science Research Center, Battelle Memorial Institute, Columbus, Ohio*

A mathematical model for human decision making in control systems is presented. The model is constructed to perform four modes of control: (1) probing mode, (2) gradient mode, (3) heuristic mode, and (4) terminal mode. The operation of the model switches from one mode to another by following certain decision logic, which simulates the function of a human operator in a control system and the evolution of heuristics for control. The results compare with experimental data.

67.2 Human Communication in Complex Systems, *R. L. Ackoff, Univ. of Pennsylvania, Philadelphia*

Popular misconceptions among information technologists and system designers seem to lead to ineffective, if not harmful, information subsystems in complex man–machine systems. These include: (1) Decision makers require more information more rapidly. (2) If they have the information they want, their decisions will improve. (3) Improved communications among decision makers necessarily implies improved system performance. These assumptions are critically examined and alternative assumptions constructed to replace them. Finally, a control system design procedure is described that is based on these alternative assumptions.

67.3 STSD—A Language for the Analysis of Military Command and Control Systems, *J. N. Bloom, Technical Director, Systems Science Div., The Franklin Institute Research Labs., Philadelphia, Pa.*

Military command and control activities are extremely complex man–machine information-processing organisms that must continuously evolve in the light of changing external conditions and internal capabilities. Moreover, because the exercise of high-level command is essentially a highly personalized and individualistic phenomenon, operating command and control activities encompass areas of considerable ambiguity. The design of automated (computer, communication, and display) systems to support command and control activities begins with an analysis of system function and operation. This analysis demands a rather specialized "requirements" language capable of specifying both information and process with sufficient specificity to permit automation while retaining sufficient ambiguity to permit the organism to search out alternative avenues for adaptive behavior. Standardized Terminology for Systems Design (STSD) was developed at The Franklin Institute Research Laboratories for this purpose. STSD employs a hierarchical verb structure to specify process and a set of noun trees to delineate information. A number of modifiers make it possible to record frequency, priority, importance, personnel manning, etc., to permit cost effectiveness considerations to be incorporated in the analysis. The vocabulary and syntax of STSD are developed and then illustrated with examples from real-world on-going command and control situations. Application of STSD to the design of industrial command and control complexes is discussed.

67.4 Conversation with Computers in the Operation of Sea Traffic Control, *J. S. Elmaleh, N. S. Prywes, Moore School of Electrical Engineering, Univ. of Pennsylvania, Philadelphia; J. F. Gustaferro, Computer Command and Control Co., Philadelphia, Pa.*

An experiment conducted to explore and study man–computer conversation in a large dynamic information system is described. The experiments were conducted using The Moore School Problem Solving Facility, which consists of a large computer (IBM 7040), mass memory (IBM 1301), satellite processor (PDP-8) connected through telephone to printer and CRT consoles. The specific information system deals with movement and characteristic of ships of many kinds and nationalities in the North Atlantic. The conversation involves querying, modifying, adding, and past and future projection.

SESSION 68

Thursday 2:00–4:30 P.M.
New York Hilton, Regent Room

Sponsored by Broadcasting Group

Expanded Broadcast TV Coverage Through the Medium of CATV

Chairman: A. B. Covey, Ridgewood, N.J.

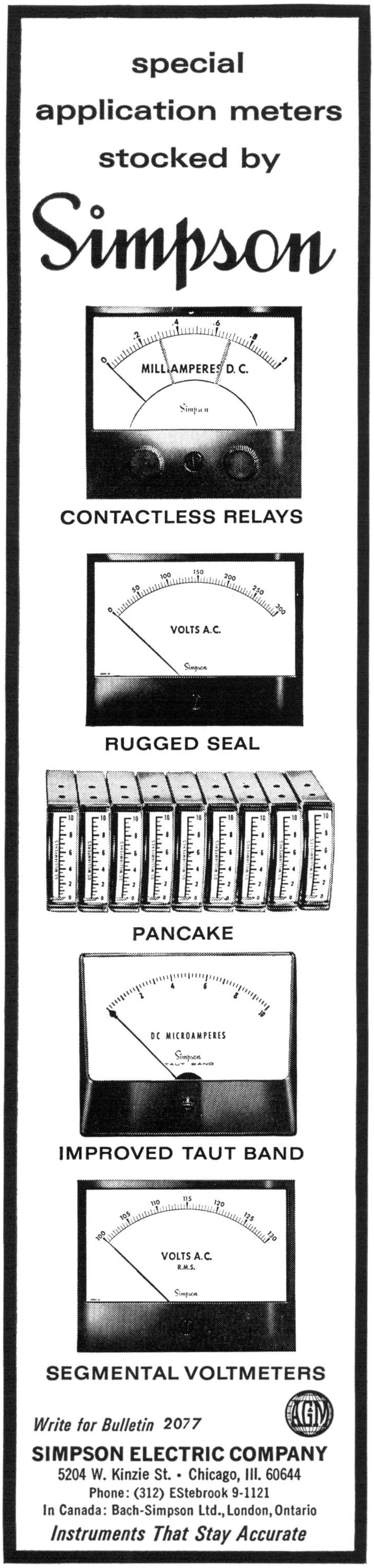
There are only 612 television broadcast stations in the United States to serve the populace. The coverage of these stations is not sufficient to serve the many hundreds of communities in this country. (There are some 4699 communities of more than 2500 people throughout the United States.) This deficiency in coverage has been filled since 1949 by community antenna systems, thereby rendering an important public service. At the present time there are more than 2000 of these systems in operation and some 2500 others where franchises have been granted or are on application. Most of the community antenna systems installed in the past have been relatively small mileage-wise, being restricted to small towns. However, recently installations have been made in cities such as Toledo, Ohio, and New York. The large cities present many new problems as well as re-emphasize some of the older problems, particularly as regards overall length, quality, electromagnetic radiation, and economy. Recently, new techniques and developments have made possible solutions of these problems.

68.1 Practical Application of a High-Level CATV Transmission System, *J. R. Palmer, President, C-Cor Electronics Inc., State College, Pa.*

New dimensions are available for CATV transmission system design and operation with the availability of high-output amplifiers. Trunk system design with these units is examined with particular emphasis on different amplifier gains. High-output bridging amplifiers and their effects on feeder system design is discussed. A detailed study of safety factors in system design is undertaken.

68.2 Expanded Broadcast Coverage (TV) Through the Medium of CATV, *J. L. Reinsch, Pres., Cox Broadcasting Corp., Atlanta, Ga.*

The growth of commercial television broadcasting has been enhanced by governmental policies favoring expanded broadcast coverage. However, inherent technical and economic features in the television medium prevent full development of television services by regular broadcast methods. Community Antenna Television (CATV) performs a vital public service by expanding television coverage. Emergence of CATV as an alternate means of satisfying expanded television needs is causing a dramatic reappraisal of the present television system. Many broadcasters and others are resisting CATV's growth. Others are joining it. Resolution of the many divergent positions is a growing concern for government, the CATV and broadcasting industries, and allied fields that could be affected by the final outcome.



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68.3 An 18-GHz Wideband Distribution System—Propagation Tests, *H. J. Schlafly, Vice Pres., TelePrompter Corp., New York, N.Y.*

On April 27, 1966, the FCC granted an experimental license to the TelePrompter Corporation to explore the practicalities of a wideband, short-range, multichannel television communication service operating in the vicinity of 18 000 MHz. The results of the experiment are reviewed and conclusions offered as suggested by New York City's propagation experience during the last six months of 1966.

SESSION 69

Thursday 2:00–4:30 P.M.
New York Hilton, Rhinelander Gallery North

Sponsored by Circuit Theory Group

Integrated Analog Circuits

Chairman: P. B. Myers, The Bunker-Ramo Corp., Canoga Park, Calif.

As integrated circuits become firmly established in today's technology, the initial preoccupation with digital applications is moderating and activity in analog integrated circuits is increasing. This session presents a sampling of analog activity including two analytical papers and three applications papers from both military and commercial fields. The first paper is of special importance; it demonstrates the utilization of automatic data-processing equipment in integrated circuit design.

69.1 Amplifier Designs Using Repetitive Stabilized Gain Elements, *G. W. Haines, B. E. Amazeen, Integrated Circuit Development, Sprague Electric Co., North Adams, Mass.*

Low-pass amplifier synthesis techniques are developed that use *RC* embedding of repetitive, broadband, dominant-one-time-constant gain blocks. Maximally flat magnitude, maximally flat delay, and equal-ripple designs in the region of 10 MHz are used as specific examples. Frequency response and its sensitivity to ambient and manufacturing variations are calculated and compared with measured data.

69.2 Realization of Real Transmission Zeros Using Uniform Distributed RC Networks with Common Ground Connections, *J. J. Stein, Hughes Aircraft Co., R&D Div., Culver City, Calif.; S. S. Shamis, J. H. Mulligan, Jr., Dept. of Electrical Engineering, New York Univ., Bronx, N.Y.*

A synthesis procedure is described for the realization of transfer functions for uniform distributed *RC* networks having all their transmission zeros on the negative real axis of the complex frequency plane. The synthesis is in the form of a cascaded ladder network having a common ground plane throughout the circuit. The requirement of a common ground plane, important in the design of microelectronic integrated circuits, gives rise to unique relations for achieving the proper transmission zeros. The use of the procedure is illustrated by several design examples.

69.3 An Integrated Circuit Helmet Radio Receiver, *R. A. Gilson, U.S. Army Electronics Command, Ft. Monmouth, N.J.; T. B. Quaid, Military Electronics Div., Motorola Inc., Chicago, Ill.*

The design and development of an IC FM receiver is described, with emphasis on the unique aspects of integrated circuit design. Seven silicon monolithic linear integrated circuits of five different types are employed in the VHF receiver, and each of these is described individually. Also discussed is the degree of realization of the overall design goals, namely, optimum performance, low cost, low power drain, and high reliability.

69.4 The Application of Commercially Available Integrated Circuits in FM and AM Radio Receivers, *G. R. Madland, R. L. Hartley, Integrated Circuit Engineering Corp., Phoenix, Ariz.*

The use of commercially available integrated circuits has been investigated in AM and FM radio receiver applications. New system design problems and compromises occur. The performance of these systems is compared with typical receivers made using discrete components. Some conclusions are made regarding presently available units and suggestions for improvement.

69.5 An Integrated RC Oscillator for Touch-Tone, *W. H. Orr, Bell Telephone Labs., Inc., Allentown, Pa.; R. M. Rickert, Bell Telephone Labs., Inc., Indianapolis, Ind.; D. M. Hill, Bell Telephone Labs., Inc., Allentown, Pa.*

A multiple-frequency *RC* oscillator for use in Touch-Tone telephone has been made using tantalum films and beam-leaded silicon devices. The integrated design, an equipment of over 50 discrete components, requires volume of less than 0.04 cubic inch. All eight frequencies of the tone generator are initially tuned to 0.1 percent.

SESSION 70

Thursday 2:00–4:30 P.M.
New York Hilton, Rhinelander Gallery South

Sponsored by Antennas and Propagation Group

Antenna and Scattering Techniques for Determining Surface Characteristics

Chairman: P. H. Smith, Bell Telephone Labs., Inc., Whippany, N.J.

The probing and interpretation of surface characteristics by radio and microwave reflections have received new emphasis in recent years by scientists engaged in geophysical prospecting, surveying planetary surfaces, and military mapping. Several papers in this session are devoted to the treatment of principles and techniques of determining electromagnetic scattering from extended surfaces. Associated problems in antenna designs suited to measuring surface scattering parameters are discussed, with particular emphasis on data processing antenna methods. New experimental data are presented that throw light on the influence of variations in polarization, wavelength, roughness, losses, propagation modes, and statistically determined parameters that affect the radar picture of the scattering surfaces. The invited papers were selected to elucidate the latest advances in techniques and theory that permit diagnostics of complex surfaces by the reflection of radio waves.

70.1 The Use of Multiparameter Radar Imagery for the Discrimination of Terrain Characteristics, *R. D. Ellermeier, D. S. Simonett, L. F. Dellwig, Univ. of Kansas, Center for Research in Engineering Science, Lawrence*

Comparison of multiparameter radar imagery has proved to be an effective technique for aiding discrimination of terrain characteristics. The parameters considered are: (1) frequency of the incident signal, (2) polarization of the incident signal, and (3) polarization of the return signal. For a radar system capable of transmitting orthogonally polarized pulses on an alternating basis, and also of receiving both direct and cross-polarized components simultaneously for each incident polarization, four separate pieces of information are available for the terrain under observation: two direct and two cross-polarized returns. However, since reciprocity holds for the cross-polarized returns, only one is used for comparison purposes. If, in addition to the variation in polarization, a variable-frequency capability is added (in this case additional radar systems operating at single frequencies), an additional parameter is added to the matrix. Variations in imagery obtained under these multiparameter conditions are, in some cases, very pronounced, whereas in other cases either little or no variation is observed. Correlation of observed variations with ground truth information is under way and insight is being gained into the boundary states and associated scattering phenomena that produce the variations. A number of slides showing combinations of congruent multiparameter imagery that enhance terrain differences are shown and discussed on a qualitative basis. These slides focus on discrimination of value in agriculture, geology, coastal, and urban studies.

70.2 Electromagnetic Scattering Phenomena Associated with Extended Surfaces, *J. K. Schindler, Microwave Physics Lab., Air Force Cambridge Research Labs., L. G. Hanscom Field, Bedford, Mass.*

The physical phenomena associated with the electromagnetic scattering from extended surfaces are summarized from the viewpoint of relating electromagnetic observables to the physical properties of the surface. Flat, curved, periodic, and random surfaces are considered separately to ascertain when the effects of surface electrical properties and geometric shape properties can be distinguished and when these effects can be used to yield information regarding the surface properties.

70.3 Direct Backscatter of HF Radio Waves from Land, Seawater, and Ice Surfaces, *G. H. Hagn, Stanford Research Institute, Communication Lab., Menlo Park, Calif.*

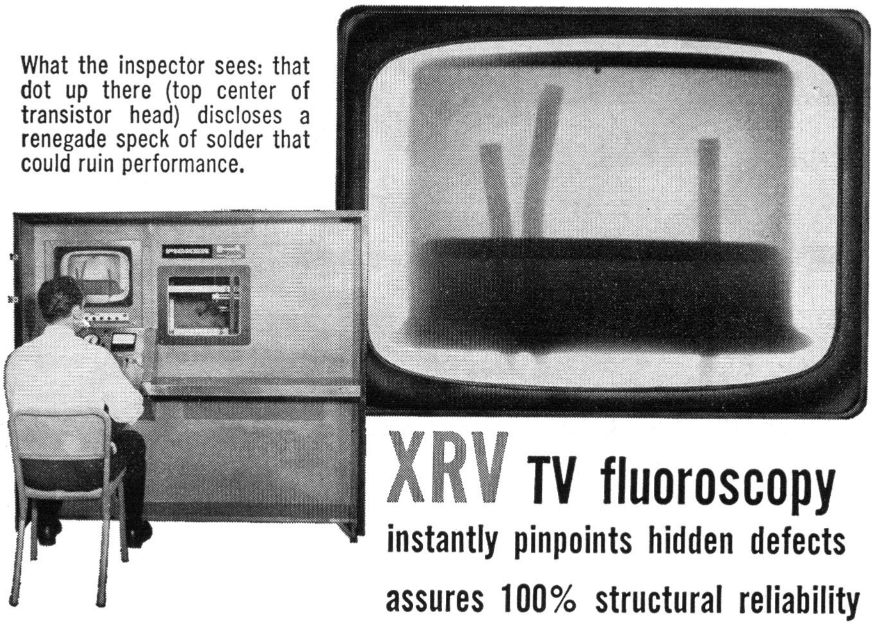
An airborne high-frequency radar operating at 32.8 MHz was used to investigate the backscatter of radio energy from the earth's surface (ocean, polar sea ice, and selected land surfaces). These data, reported as a backscatter reflection coefficient, indicate that surface roughness is the dominant characteristic in determining the amount of backscatter for a specified angle of incidence (i.e., depression angle), wavelength of 30 feet, and given polarization. Smooth surfaces (scale of roughness small compared with 30 feet) exhibit a strong dependence of the backscatter reflection coefficient upon depression angle, and polarization effects are pronounced. No orderly angular dependence is apparent for either polarization when the surface is rough. The question of whether land or sea produces greater echoes is examined; the answer depends upon the angle of incidence upon mean ground level, polarization, and the surface roughness.

70.4 Generalized Surface Impedance Properties, *R. K. Ritt, K. M. Siegel, Conductron Corp., Ann Arbor, Mich.*

For a large class of surfaces the boundary condition $T[E_{\tan}] = S[H_{\tan}]$ can be shown to be applicable. $E_{\tan}$, $H_{\tan}$ are respectively the tangential components of the electric and magnetic field, and T and S are linear transformations depending on the physical properties of the surface and the wavelength. This is a general impedance boundary condition that connects physical properties of the surface to its scattering properties.

70.5 Antenna Processing for High-Resolution Mapping, *A. A. Ksienski, Hughes Aircraft Co., Culver City, Calif.*

Various quality criteria for mapping are compared, followed by a discussion of resolution criteria and limits. The properties of the signal



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and noise, such as time–space (non)stationarity and degree of coherence, are shown to lead to particular choices for mapping systems. A general (decision theoretic) approach is presented that yields the optimum array configuration and signal processing. This approach is shown to yield most of the presently used techniques as special suboptimum cases. Examples of such cases are multiplicative arrays, nonreciprocal arrays, synthetic apertures, etc. The space–time decision theoretic approach applies to a variety of problems such as surface mapping, multiple reflector detection and resolution, and pattern recognition.

SESSION 71

Thursday 2:00–4:30 P.M.
New York Hilton, Sutton Ballroom North

Sponsored by Publications Board

Scientific and Technical Communication

Chairman: F. K. Willenbrock, Associate Dean of Engineering and Applied Physics, Harvard University, Cambridge, Mass.

The purpose of the session is to summarize in as simple terms as possible the situation of scientific and technical communication. It also presents the aims and goals of IEEE as an important segment of the technical community. The first paper reviews the whole problem of information that is expanding so rapidly and reports methods for coping with its flow and eventual use. Because IEEE is deeply involved in a large publications activity, it is evolving plans for both the immediate and distant future in order to serve both its members' needs and those of workers in allied fields. A demonstration of the on-line information system that may be typical of the future will be provided by Project TIP using facilities of the MAC time-shared computer network at Massachusetts Institute of Technology. Because libraries still constitute our formal store of information, the means for integrating their operations into more advanced systems of information storage and retrieval is discussed. Of great practical importance is the effect of the eventual information network on our present conventional systems, including the publication of books and journals. How individuals will interact with information in the future is suggested in the last paper.

71.1 Perspectives on the Panorama of Scientific and Technical Information, *F. J. Weyl, National Academy of Sciences/National Academy of Engineering, Washington, D.C.*

The universe of scientific and technical information, expanding at a worrisome speed, affects all dimensions at once: the apparently uncontrollable growth of volume at an exponential rate; the size of the individual effort in science and technology to be fueled by the available pertinent information; the cost of structuring and disseminating it for ready access; and, finally, the penalty incurred by the failure to use it fully and effectively. Guidance in coping with these problems derives from three sources: intellectual insight into its objective structure and the cause-and-effect inevitabilities tying it together; performance capabilities of systems that can be engineered and operated; and management practices and policies serving useful ends. This country's institutions that effectively exercise stewardship of scientific and technical information are reviewed and their adequacy is discussed.

71.2 Plans for Information Services to Be Sponsored by IEEE, *H. E. Tompkins, University of Maryland, College Park, and IEEE Consultant*

Information services can be considered to include all of the normal publication and meeting activity of IEEE. However, this discussion will focus on additional services that might become possible in the not-too-distant future using modern computer-based technology. A most important element in the plans is cooperation with other scientific and technical societies in physics, mathematics, and computer science and engineering.

71.3 An On-Line Technical Information System at M.I.T. (Project TIP), *M. M. Kessler, Massachusetts Institute of Technology, Cambridge*

The facilities of the MAC time-shared computer network at M.I.T. are now being used for storage and access to the physics journal literature. Information from 30 journals over a three-year period may be searched in real time and in a variety of ways to retrieve pertinent bibliographies on various subjects. A search language and strategy have been developed that allow direct user operation without recourse to trained operators or documentarians. The system will be described and demonstrated with direct hook-up to the computer.

71.4 The Mechanization of Libraries, *I. A. Warheit, International Business Machines Corp., San Jose, Calif.*

Librarians, who initially showed little interest in applying computers, wanted machines that could provide direct access to a very large number of records. With this requirement in mind, programs were undertaken to develop new mechanized systems for libraries. Present emphasis is on traditional housekeeping or operational functions of acquisitions, serials and circulation control, and cataloging. At first, this will not radically change library operations. Later, when a mechanized store has been built up, the more serious problem of how to use the stored information must be faced. Then the revolution in librarianship is expected.

71.5 The Information Network: How Will It Affect Conventional Publishing? *Oliver Selfridge, M.I.T. Lincoln Laboratory, Lexington, Mass.*

The community of large-scale on-line computers will be a real one in a few years. The old time scale of cooperation with data and programs was of the order of months. Surely the members of this coming community will need to be effectively on line with each other, just as the users of each installation were. What are the problems of the communications net and of controlling it? What is the role of the information about the net—that is, the documentation?

SESSION 72

Thursday 2:00–4:30 P.M.
New York Hilton, Sutton Ballroom South

Sponsored by Audio and Electroacoustics Group

Speech Processing

Chairman: Homer Dudley, Consultant, Summit, N.J.

Actually speech processing starts in the brain as the person about to speak or write searches for words, sounds, and grammatical structure to process his idea into suitable language for expression. Again, speech processing is used to convert from the spoken word to the written and vice versa. Live speech can be processed by the vocoder to obtain low-frequency parameters comparable to those in the visible speech processing involved in lip reading. Written speech processing occurs in editing, also in ciphering, and in translation. Speech processing known as pulse code modulation (PCM) has recently found considerable application in communication circuits. The present papers deal chiefly with speech pickup, analysis, and synthesis.

72.1 A New Highly Sensitive Subminiature Condenser Microphone, *Yasuhiro Rikow, Matsushita Communication Industrial Co., Ltd., Yokohama, Japan*

A new subminiature condenser microphone with high sensitivity (5 mV/μb ± 1 dB over 20 Hz – 18 000 Hz at polarization voltage 30 volts dc), with small size (1/4-inch diameter, 1/2-inch length) and without active elements is described. Mechanical impedance of membrane and its load was very low. Titanium foil of 0.4-mil thickness was used for the membrane.

72.2 Bandwidth Compression of Speech by Analytic-Signal Rooting, *M. R. Schroeder, J. L. Flanagan, E. A. Lundry, Bell Telephone Labs., Inc., Murray Hill, N.J.*

A real, band-limited signal, $s(t)$, has a corresponding analytic signal defined as $\sigma(t) = [s(t) + j\hat{s}(t)]$, where $\hat{s}(t)$ is the Hilbert transform of $s(t)$. Under certain conditions, the analytically rooted signal defined as $s_{1/n}(t) = \mathrm{Re}[\sigma(t)]^{1/n}$ occupies approximately $1/n^{th}$ the bandwidth of $s(t)$. The inverse operation, applied to the rooted signal, recovers the original signal, that is, $s(t) = \mathrm{Re}[s_{1/n}(t) + j\hat{s}_{1/n}(t)]^n$. A speech transmission system based upon these relations has been simulated on a digital computer. At the transmitter, contiguous frequency bands of speech are analytically square-rooted and band-limited to one half of their original frequency band. At the receiver, these band-limited signals are analytically squared to recover a good approximation to the original signal. Results of the computer simulation for 2:1 band conservation will be demonstrated.

72.3 Experimental, Limited Vocabulary, Speech Recognizer, *C. F. Teacher, H. Kellett, L. Focht, Philco-Ford Corp., Blue Bell, Pa.*

A limited vocabulary speech recognizer has been built that uses just three speech parameters—the narrow-band speech envelope, the state of voicing, and the frequency of the "single equivalent formant." The device employs combinatorial logic to recognize up to six "feature segments" of the desired word. Final recognition is achieved when all segments have been detected in their proper sequence and within predetermined time constraints.

72.4 Speech Processing Techniques and Applications, *H. F. Olson, Herbert Belar, E. S. Rogers, RCA Labs., Princeton, N.J.*

The processing of speech involves the analysis, coding, decoding, and synthesis of speech sounds. The speech analyzer consists of normalizers, syllable and syblet segmenters, sound recognizers, sequencers, adapters, and memories which converts the speech elements into a code. The speech synthesizer converts the code to speech by reproducing prerecorded speech elements. There are many applications for the speech analyzer and synthesizer ranging from limited vocabulary to complete communication systems.

72.5 Communication Transmission Requirements as Seen by Astronauts and Aquanauts, *Scott Carpenter, Manned Spacecraft Center, Houston, Tex.*

The requirements of men in a hostile environment necessary to the safety and efficient conduct of their mission are considered. Equipment and data regarding position, velocity, range rates, homing, tracking, digital information, and voice communications are explored.